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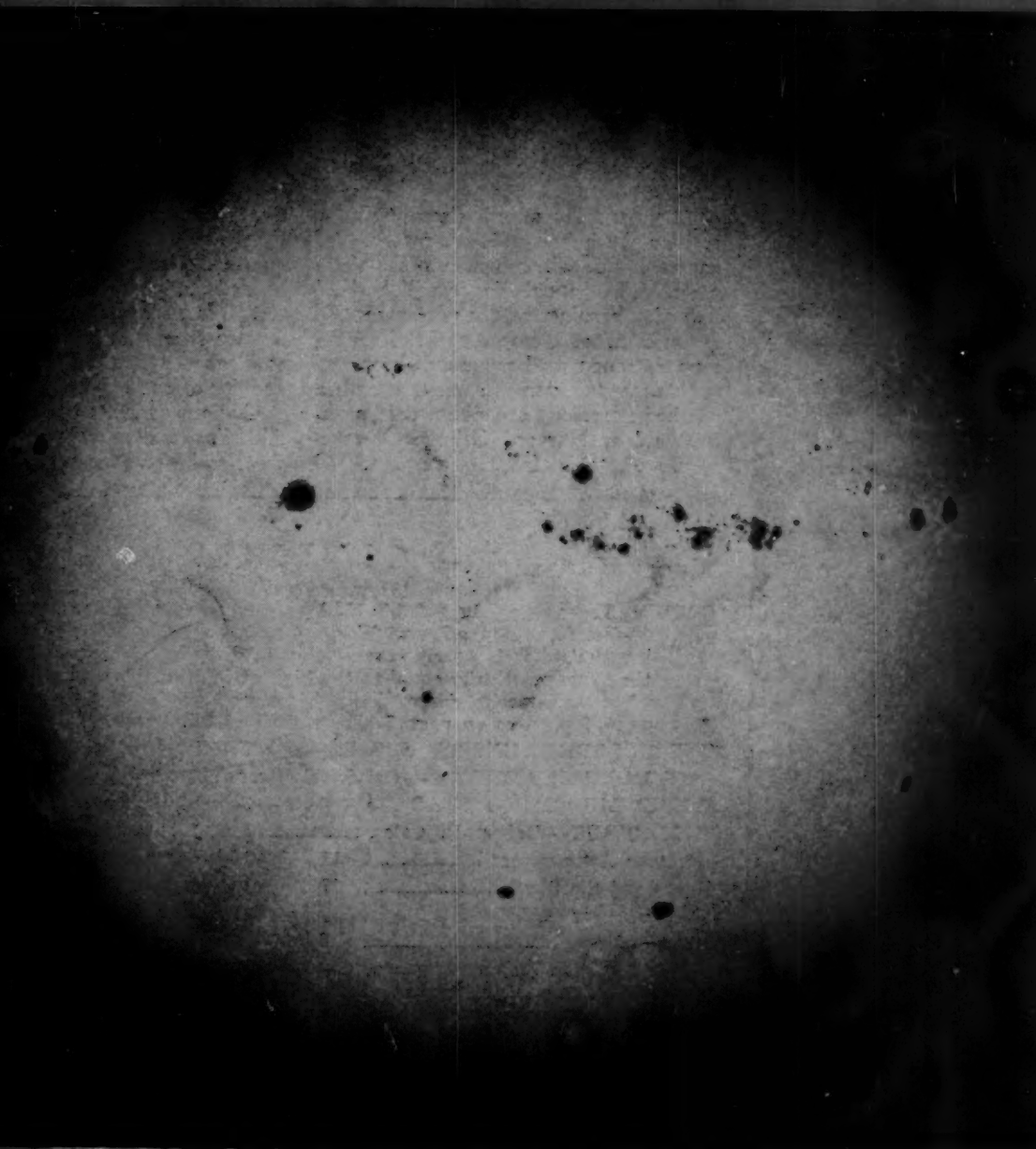

August sunspots

★
Vol. VI, No. 12
OCTOBER, 1947
Whole Number 72
25 cents
★

In This Issue

The Current Sunspot Cycle
Popular Photometry
Durer and Early Star Maps — II
Fall Skies
Stars for October

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Sky and TELESCOPE

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AAVSO and League Region to Meet at Harvard

The 36th annual meeting of the American Association of Variable Star Observers is scheduled for October 10th and 11th, at Harvard College Observatory, in Cambridge, Mass. The first session is at 8 o'clock on Friday evening, when Dr. Charles H. Smiley, AAVSO president, will talk on his expedition to see the eclipse in Brazil in May, his title being, "15,000 Miles and 15,000 Observations." The AAVSO will be host to the Bond Astronomical Club on this occasion.

The Saturday morning session is for regular business, and presentation of papers, which will continue in the afternoon. The annual dinner will be held Saturday evening, at the observatory.

On Sunday, October 12th, all Amateur Astronomers League members, and any interested persons, may attend a northeast region organizational meeting held at Harvard College Observatory. As this follows the AAVSO meeting of the preceding day, and as Monday is a holiday for many persons, it is hoped that attendance from the proposed northeast region will be large. At present, the tentative region includes New England, New York state, and northern New Jersey.

The first session will be at 10 o'clock Sunday morning, at the observatory, and will continue through lunch and into the afternoon if necessary. There is no advance schedule of papers or activities, as the meeting is to be an organizational one. Problems for discussion will be the establishment of regional headquarters; election of temporary regional council and officers; discussion of activity sections and program plans of amateurs and societies in the region; and other matters necessary for initial activity of the region.

Co-hosts for the meeting are the ATM's of Boston, the AAVSO, and the Bond Astronomical Club.

VOL. VI, NO. 12
WHOLE NUMBER 72

CONTENTS

OCTOBER, 1947

COVER: The sun on August 14, 1947, photographed with the tower telescope of 60-foot focus at the Mount Wilson Observatory. On the original contact print the sun's disk is nearly seven inches in diameter. The sunspot count at this time was practically equal to the highest in May. Two weeks later, however, when the opposite side of the sun was seen, spots were few, as shown by the pair of pictures on page 5. Mount Wilson photograph. (See page 3.)

THE CURRENT SUNSPOT CYCLE — Seth B. Nicholson 3
POPULAR PHOTOMETRY — Gerald E. Kron 7
DÜRER AND EARLY STAR MAPS — II — Samuel G. Barton 12
FALL SKIES — Robert R. Coles 14

Amateur Astronomers 11
Books and the Sky 17
Gleanings for A.T.M.s 19
News Notes 6
Observer's Page 22
Planetarium Notes 25
Stars for October 26
Terminology Talks 10

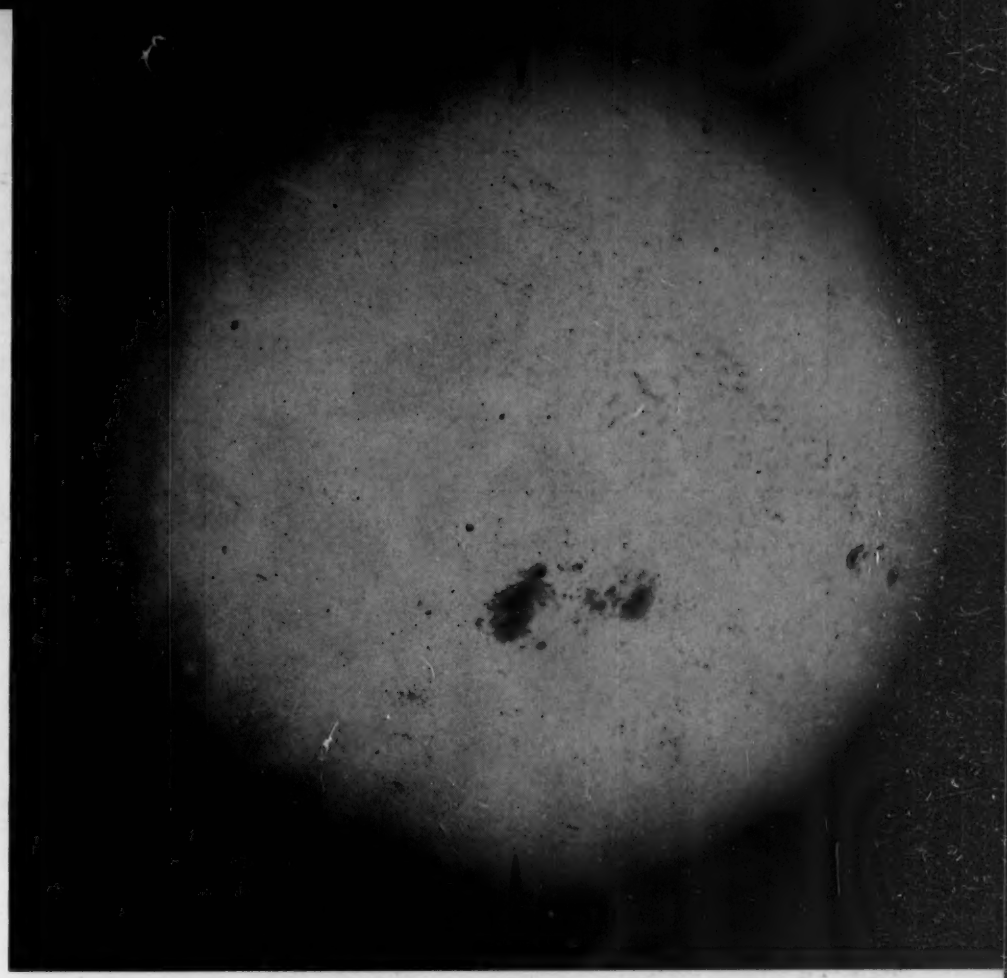
BACK COVER: The largest group of sunspots ever recorded, enlarged from a picture taken with the tower telescope of the Mount Wilson Observatory on April 7, 1947. Its maximum area measured at Greenwich Observatory was 6,300,000,000 square miles. Its maximum length was 200,000 miles. North is at the right. Mount Wilson photograph. (See page 3.)

SKY AND TELESCOPE is published monthly by Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass. Entered as second class matter, April 28, 1939, at the Post Office, Boston, Mass., under Act of March 3, 1879; accepted for mailing at the special rate of postage provided in Paragraph 4, Section 538, Postal Laws and Regulations.

Subscriptions: $3.00 per year in the United States and possessions, and to members of the armed services; Canada and all countries in the Pan-American Postal Union, $3.50; all other foreign countries, $4.00. Make checks and money orders payable to Sky Publishing Corporation. Send notice of change of address two weeks in advance. Circulation manager: Betty G. Dodd.

Editorial and general offices: Harvard College Observatory, Cambridge 38, Mass. Unsolicited articles and pictures are welcome, but we cannot guarantee prompt editorial attention, nor are we responsible for the return of unsolicited manuscripts unless return postage is provided by the author.

Advertising director: Fred B. Trimm, 19 East 48th Street, New York 17, N. Y.; ELdorado 5-5750.



The sun on April 6, 1947, showing the largest group of sunspots ever recorded. This group is enlarged on the back-cover reproduction. North is at the top. All illustrations in this article are by Mount Wilson Observatory.

The Current Sunspot Cycle

By Seth B. Nicholson, *Mount Wilson Observatory*

NEVER BEFORE has the sun's surface been so closely watched as now. The present interest in the sun was not caused, however, by the unusual solar activity now taking place; it began nearly 15 years ago, before the last sunspot maximum, and increased right through sunspot minimum. This interest was fathered by the discovery that radio reception varies with changes in solar activity. Its growth was accelerated in 1935 when J. H. Dellinger, of the National Bureau of Standards, found that high-frequency radio fade-outs were produced by solar flares. As communication by short-wave radio became used more extensively, the effects of changing solar radiation on the ionosphere became more and more obvious. Wartime needs stimulated the study of these solar effects, with the result that many people who had never heard of sunspots before became quite conscious of them.

Since the V-days, radio waves originating in sunspots have been studied extensively with techniques developed during the war. The discovery of these direct terrestrial effects of sunspots has been primarily responsible for the present interest in the sun and his spots. To encourage observers of the sun and to coordinate their results, a solar section of the American Association of Variable Star Observers has been organized with scores of active members now enrolled.

Since the beginning of the current cycle, sunspot activity has increased rapidly. Perhaps the sun, flattered by so much attention, decided to put on a real show. At any rate, solar observers have been rewarded by the rare opportunity of witnessing the greatest solar activity in centuries — sunspots in the present cycle have broken many of the old records. The largest single sunspot (penumbral area including umbrae) ever recorded appeared in March, 1947. By April, this spot had divided into several parts which grew to form the largest group of spots ever observed. Until last year this record had been held by a group in January, 1926. It had been broken by a huge group in February, 1946, which exceeded the area of the group in 1926 by some 30 per cent. The group in April, 1947, broke the 1926 record by nearly 50 per cent. A group in July, 1946, also surpassed the old record, but only by a narrow margin, failing to equal the new record.

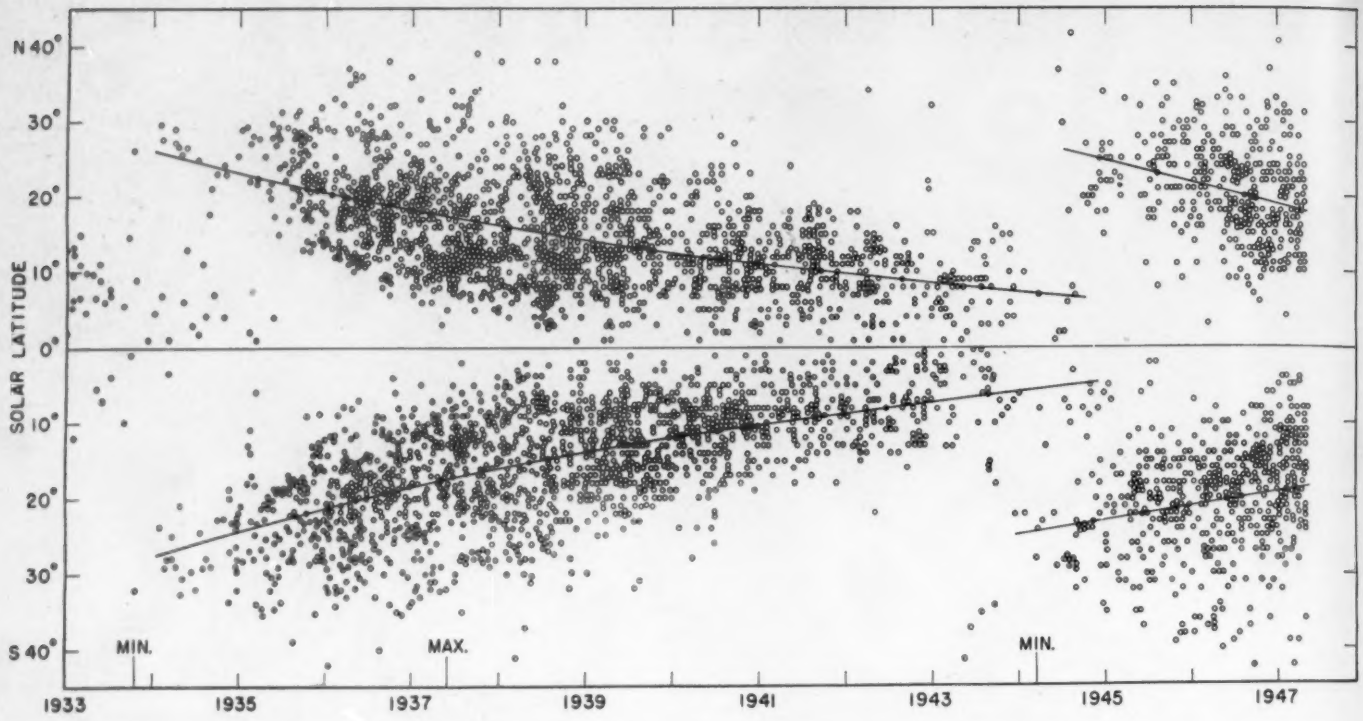
Although naked-eye sunspots had been observed and recorded occasionally before Galileo's time, it was not until telescopes were used that any details about sunspots became known. Galileo and the early observers who followed him determined that sunspots were actually on the sun, not objects coming between us and the sun, and that the sun rotated slowly, carrying the spots across its disk in about two weeks. That the number of sunspots varied from month to month and from year to year was known, but these variations were thought to be irregular and sporadic. In fact, sunspots had been observed for more than 200 years before the cyclic nature of their fluctuations was recognized. In 1843, after 20 years of continuous solar observing, Samuel Heinrich Schwabe announced that his observations showed a definite periodicity of about 10 years in the frequency of sunspots. It is probable that this periodicity would have been recognized sooner if it had been more regular. The period of the sunspot cycle varies by as much as 10 or 20 per cent, the amplitude of the variation even more. There was, moreover, an interval of about 70 years, from 1643 to 1715, during which very few spots appeared on the sun. The only ones recorded in those years were at times corresponding to sunspot maxima but their numbers were scarcely more than are seen in some years of sunspot minimum.

Discussing this dearth of sunspots, E. W. Maunder wrote in *Knowledge*, for August, 1894:

It may be objected, perhaps, that bearing in mind the feeble instruments of those days, and the paucity of observers, it may well have happened that many spots may have passed unnoticed during the seventy years in question. But no great instrumental power is needed to detect the presence of a sunspot, and indeed a single diligent observer using his unassisted sight during the last twenty-five years would have compiled a far heavier record than all the astronomers of Europe have been able to hand down to us for the years between 1643 and 1715. Besides, telescopes were certainly considerably more powerful than those in use earlier in the century. Yet we have but to refer to the works of Galileo, or to the plates, drawn with such evident care and fidelity, which adorn Scheiner's huge "Rosa Ursina," to be assured that outbursts such as the sun presented in 1625-27 could never have passed unnoticed fifty years later.

In the same article, Maunder, emphasizing the importance of that interruption of sunspot activity in "guiding us to a right understanding of the solar ebb and flow," said:

In the meantime it [the interruption] stands as a warning to us against too hasty a generalization. Two centuries of a fairly cyclical oscillation would not have justified us in premising a like condition of things in the half century that preceded



DISTRIBUTION OF SUNSPOTS IN LATITUDE

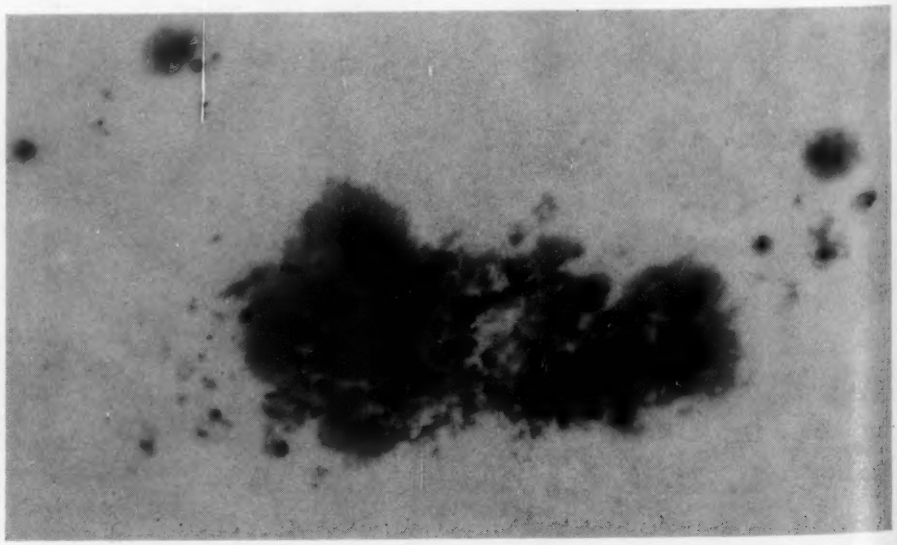
Each group of sunspots is plotted as a circle according to its solar latitude and the time it appeared. No account is taken of the size or duration of the group. The full lines indicate the mean distance of the spots from the solar equator. The overlapping of the cycles at minimum is clearly shown. Times for maximum and minimum are from the Zurich relative sunspot numbers.

them. Clearly, however likely we may consider it that the present cycle [1894] will run much the same course as its immediate predecessors, we are not justified in prophesying it. What has happened before may happen again, or even its reverse; for who shall say it is impossible that, as for so long a time the keynote of solar energy was lowered to such a degree, so for an equal time it may not be proportionately raised? If so, we or our descendants may see our sun as an unmistakable variable star; for the vague traditions which have reached us from the middle ages may be realized, and for a greater or less time the sun may be so covered with spots as to lose a very appreciable portion of the light of its general surface.

In this case we should probably find the faculae and prominences developed in something like the same proportion, and the sun might well earn the title of a "bright line star" in a sense which we have never known it to do as yet. And its spectrum would approximate to those of the transitory enigmas which have puzzled us so sorely — the "temporary" stars of Auriga, of Norma, and of the Northern Crown.

Shortly after Schwabe called attention to the periodicity of sunspots, Rudolf Wolf began a remarkable series of solar observations upon which he based an investigation of the solar cycle. Using all available data about sunspots, he expressed the solar activity on each day by a relative index number from which monthly and yearly means could be obtained. This series of sunspot numbers, which has been continued at Zurich under the direction of A. Wolfer, W. Brunner, and M. Waldmeier, furnishes a most remarkable record of sunspot activity. The arbitrary relative spot number selected by Wolf was the sum of the number of individual spots plus 10 times the number of groups. The relative numbers from observations made with different telescopes are multiplied by factors to reduce them to a homogeneous scale. These factors vary from 0.5 to 2.0, depending on the size of the observer's telescope and on his zeal. The factor used for the Zurich observers, which was originally 1.0, is now 0.6. A relative spot number of 180 assigned to a particular day does not mean that 180 sunspots were observed on that day. More likely there were some 100 individual "spots" distributed in 20 groups, or 150 "spots" in 15 groups. Either combination observed at Zurich will give a relative number of 180.

Obviously, it is very difficult to determine reduction factors which will make the present mean relative numbers comparable with those from observations 200 years ago. A modern practice, which has been followed for many years, is to disregard the natural unit of a sunspot (a penumbral area usually containing one or more umbrae) and to count each



The largest single sunspot, a single penumbral area containing many umbrae, March 10, 1947. This spot broke into the large April group.

umbral or penumbral condensation. Thus a sunspot with five umbrae is counted as five, not one. It is probable that changes in the methods of counting have changed the factors as much as the use of better telescopes.

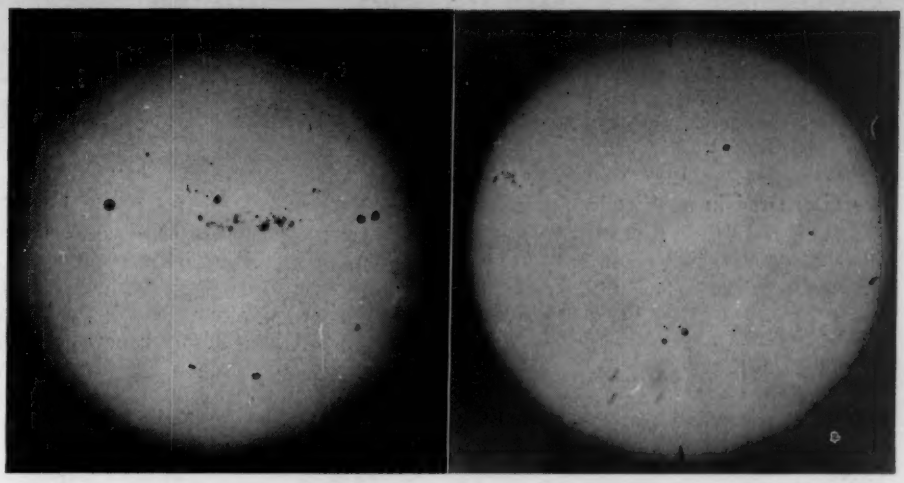
The mean sunspot number assigned to May, 1947, 206.5, was the second largest number assigned to any month since 1749. The only larger number was 238.9, for May, 1778. In December, 1836, the mean number was 206.2, essentially equal to that of last May. Only two other months, January, 1837, and October, 1847, had relative numbers larger than 180.

A study of the solar cycles of the last 200 years reveals that their periods and amplitudes have various characteristics which can be described mathematically by coefficients in equations relating phase with amplitude. Whether these generalizations have any physical significance is hard to determine, especially in view of what happened on the sun from 1643 to 1715. The cycles of the last two centuries resemble each other as people resemble each other — there may even be giants and dwarfs. Like some boys, the present cycle is growing rapidly, but its general features are like those of other cycles and its rate of growth is not much faster than that of the cycle which began in 1933.

Solar activity does not progress steadily but fluctuates, advancing in a series of spurts instead of uniformly. During the three or four years near maximum, the sunspot number fluctuates at irregular intervals of a few months by as much as 25 per cent of its maximum value. The time designated as maximum is the month for which the mean sunspot number, smoothed approximately annually, is the highest.

In the last cycle the maximum smoothed number was 119.2, for April, 1937; the highest monthly mean number was 165.3 in July, 1938, more than a year after the maximum. It is therefore obviously impossible to determine the time of maximum until at least six months after it has occurred. It is quite probable that May, 1947, will be the maximum of the present cycle but that will depend on what the sun does next. The provisional sunspot number for June was 168.9, for July 168.6, both much lower than that for May. This decrease may be only a temporary fluctuation, however, not a post-maximum decline.

Three great groups of sunspots, all larger than any previously recorded, have appeared in the current cycle. The largest of these groups developed from some small spots which were first seen on February 5, 1947, at the east limb of the sun, in latitude 23° S. These spots grew rapidly until by February 7th they formed a group large enough to be seen without a telescope. When, after a solar rotation, the group reappeared at the east limb on March 3rd, it had changed considerably, being much larger and more compact than in February.



Irregular distribution of sunspots is the rule rather than the exception. These pictures, taken August 13th (left) and August 26th, this year, show practically the whole solar surface (360° of longitude). But the greatest inequality in the present cycle has been between the northern and southern solar hemispheres, 43 and 57 per cent, respectively.

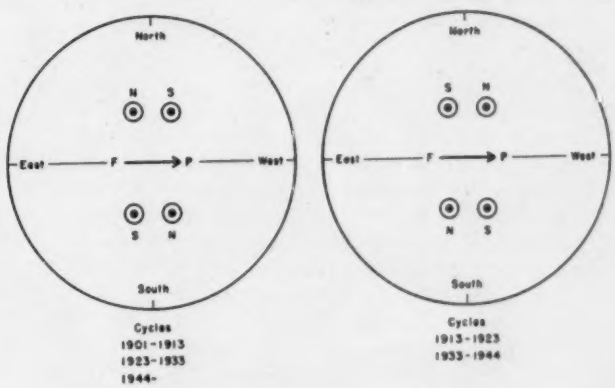
In March, the group was composed primarily of one huge spot, which had apparently developed from the preceding (western) members of the February group, the following members of which had disappeared. It is the largest single spot on record with an area of five billion square miles, 4,300 millionths of a solar hemisphere.[1]

When it reappeared on March 30th for its third transit, the huge group, although breaking up, had increased in area. When largest, it appeared to cover more than one per cent of the apparent solar disk, its area being 6,300,000,000 square miles, 5,400 millionths of the actual solar hemisphere. On its fourth and last return the group was much smaller. The preceding part, which had always been the smaller, disappeared on May 7th. The following part passed around the west limb on May 11th and did not return.

Prior to 1946, the largest group on record was that of January, 1926, with area 4,300,000,000 square miles, 3,700 millionths of a solar hemisphere. Some popular books, and even a few astronomical texts, report that a group in 1858 had an area 1/36 that of the solar disk. This erroneous statement refers to a group described by Schwabe as having an east-west diameter of 321″.6, one sixth of a solar diameter. Someone, assuming that the group was circular, gave its area as 1/36 of the solar disk. H. C. Carrington published drawings of this group, which show it as a long narrow stream of spots with a total area of only 1/500 that of the solar disk. Several groups are on record with areas more than three times that of the 1858 group.

Since 1908, when George E. Hale discovered that sunspots have magnetic fields, the distribution of polarities in the groups has changed at each minimum. In the current cycle, a group in the northern hemisphere has negative magnetic polarities in the preceding part and positive polarities in the following part; groups in the southern hemisphere have the opposite polarities. This arrangement of polarities is opposite to that in the last cycle. Magnetically, the present cy-

[1]The areas given here are from the Greenwich Observatory, which since 1874 has published the areas of sunspots measured from solar photographs. When the article, "The Great Sunspot Group of March and April 1947," by Edison R. Hoge, P. A. S. P., 59, 109, 1947, was written, the Greenwich measures of the group's area in April were not available. They now show that in April the 1947 group was larger than that of February, 1946.



The magnetic polarities of the preceding and following members of a sunspot group are opposite in the north and south hemispheres. They are reversed in alternate cycles, as shown by this chart.

cle is like that from 1923 to 1933 and that from 1902 to 1913, the one in which magnetic fields in spots were first recognized.

For the last century, sunspot cycles have alternated in amplitude, those corresponding to the present cycle having had smaller amplitudes than the cycles just preceding and following them. It seemed possible, therefore, that some physical relation might exist between the amplitude of a cycle and the magnetic polarity of the spots in it. There is little doubt that the present cycle will be more active than the last one, thus breaking a sequence of many years standing and indicating that the relation between amplitude and magnetic polarity was accidental, not physical.

All the spot groups observed since January 1, 1933, are plotted in the chart (on page 4) according to latitude and the time at which they appeared. The first group that definitely belonged to the current cycle appeared on May 16, 1943. Two very small groups that appeared on April 2nd and December 20, 1942, respectively, may also have belonged to this cycle, but they were so small and their magnetic polarities so weak that their classification is uncertain. The current cycle has had more spots per month than the last cycle at the same phase relative to the minimum, but until May, 1947, the *rate of increase* was not appreciably greater than in the last cycle and a slight change in the phase would bring the frequency curves of the two cycles together. In view of the size of the largest groups since the last minimum, it may seem strange that the relative spot number has not been even larger, until one remembers that groups and spots are not weighted according to their areas when the relative number is formed. The average latitude of the spots (heavy line in the figure) has decreased in approximately normal fashion. There has, however, been an excess of spots in high latitudes, especially in the southern hemisphere.

So many predictions have been made about the time of maximum that more would be superfluous. Perhaps the maximum has already passed, perhaps it is still a year or more in the future. Whatever time is eventually assigned as that of maximum will depend on the index used to measure solar activity and on the method used to smooth the data. To call maximum the month having the highest smoothed relative sunspot number is as good a method as any, but we should not forget its limitations and uncertainties. Whenever maximum may be, we can be assured that the current cycle is a very active one, and that for the next three or four years there will be plenty of sunspots to influence the ionosphere and to give solar observers many opportunities to gather clues concerning the nature of sunspots, what causes them, and how they affect the earth.

NEWS NOTES

By Dorrit Hoffleit

ELIS STROEMGREN DIES

In April, Elis Stroemgren, director of the Copenhagen Observatory for 33 years prior to his retirement in 1940, died at the age of 76. As he was an authority on celestial mechanics, a large share of Stroemgren's astronomical endeavors was devoted to the three-body problem. Investigating comets of nearly parabolic orbits, he was able to show that all the orbits he examined were "elliptical" and therefore true members of the solar system.

One of his most beneficial services to astronomy was his effective interest in an astronomical telegraph bureau. Only one such bureau existed prior to the first World War, at Kiel. When its disruption was imminent, he set up his own emergency bureau at Copenhagen. After the first International Astronomical Union meeting in 1922, its officially recognized bureau was moved from Brussels to Copenhagen, with Stroemgren as director.

When he retired as director of the Copenhagen University Observatory, Elis Stroemgren's greatest satisfaction and pleasure came at seeing his elder son, Bengt, appointed his successor.

AN UNUSUAL ASTEROID

Late in August, Lick Observatory announced the discovery of an unusual asteroid, by C. A. Wirtanen, who had also found a comet in July. This minor planet, which was of the 15th magnitude when first observed, proves to be one of the fastest-moving such bodies known. According to calculations by Dr. Leland E. Cunningham, of the Students' Observatory at Berkeley, Cal., it moves in a nearly circular orbit close to that of Mars, coming within 0.063 A.U., or six million miles, of Mars' orbit.

The Wirtanen asteroid never gets closer to the earth than 50 million miles, and it travels its course around the sun in about 27 months. Dr. Cunningham points out that Eros is the only numbered minor planet having a shorter period of revolution. The new object is only a few miles in diameter.

NEW POLISH OBSERVATORY

A new observatory is being erected at Torun, where Copernicus was born, to start the rehabilitation of war-wrecked Polish astronomy. The nucleus of the new observatory is Harvard's 8-inch Draper photographic doublet, of historic fame both because of its donor, and the fact that it is responsible for over 100,000 spectrum photographs classified by the late Dr. Annie J. Cannon in her 10-volume *Henry Draper Memorial Catalogue*. At Torun, the instrument will be used for research on the colors, temperatures, and chemical compositions of the stars. A cable from Professor S. Dziewulski, Polish astrophysicist, notified Harvard of the arrival of the telescope at Torun early in July.

OPTICAL SOCIETY

The 32nd annual meeting of the Optical Society of America is scheduled for October 23, 24, and 25, 1947, at the Netherland Plaza, Cincinnati, Ohio. In addition to the usual features, symposiums on aerial photography and microwave optics are being planned. The meeting is open to non-members, and all interested persons are cordially invited to attend. Further information may be had from the OSA secretary, Dr. Arthur C. Hardy, Massachusetts Institute of Technology, Cambridge 39, Mass.

METEORITES WANTED

On May 9th at 7:30 p.m., southwestern California witnessed an unusually bright fireball. Drs. Dinsmore Alter and C. H. Cleminshaw, of the Griffith Observatory, collected very large numbers of observations and have computed the path of the body, which had been observed to split into at least three fragments before it vanished. A detailed account is given in the *Griffith Observer* for August, containing maps of the region of flight and other pertinent information.

It seems probable that meteorites resulted from this fireball. The authors are so anxious to obtain specimens that they state, "We shall be glad to examine hundreds of non-meteoric fragments in the hope that one may belong to this fall." They describe what sort of objects to suspect as meteorites, and define the search area, which, of course, cannot be bounded very closely since the fragmented meteoroid vanished at an altitude of about 10 miles. "If one takes as an eastern boundary the Southern Pacific Railroad from Richgrove south for a half dozen miles, and a western boundary of the same length and parallel to this but six miles west of it, he will have a square within which most of the meteorites can be expected. Perhaps some might be found to the east of this square. Delano is very nearly on the western boundary and Richgrove at the northeastern corner of the square."

So if you happen to be in that vicinity, why not enjoy using your magnetic rake or other ingenuity to help the meteoriticists? Remember that negative results may be of scientific value, so any futile but extensive searches should be reported.

POPULAR PHOTOMETRY

By Gerald E. Kron, *Lick Observatory*

A TERRESTRIAL OBSERVER of celestial objects finds himself with little indeed upon which to make his observations. His unaided eye can only inform him of the fact that such objects as the planets and stars exist, that some of them have detectable motions, and that some of them vary in brightness and have colors different from others. An observer aided with a telescope and auxiliary equipment is more fortunate; he can measure, for example, motions and positions of astronomical objects, sometimes with high accuracy, and he can deduce numerous facts from his observations. The scope of study can be increased still further by employing elaborate instruments such as spectrographs for analyzing the quality of light, and photometers for measuring the quantity of light received from extraterrestrial objects. While knowledge of the properties of our terrestrial environment has been gained by making and interpreting physical measurements of many kinds, nearly all of the significant knowledge that has been accumulated about astronomical objects has been obtained by making measurements of only three types: micrometric, spectrographic, and photometric. These three broad classifications of measurement give us the position, the quality, and the quantity of the light we receive from objects remote from our earth. It is evident that, as one of only three major types of measurement available, photometry is of great importance to the astronomer, and it is unfortunate that he has not exploited it more fully.

Professional astronomers generally use one of three methods of photometry: visual, photographic, or photoelectric. Visual photometry is accomplished by employing the eye as a device for estimating differences or equality of brightness between objects of unknown and known brightnesses; sometimes the estimating is done directly, sometimes an optical aid is used, but always the eye is the receiver and measurer of the light. Visual methods are usually reliable and comparatively simple to use. Photographic photometry depends upon the properties of the photographic plate as a light receiver, and the size or degree of blackening, or both, of the photographic image is used to indicate the brightness of the objects being measured. When photographic methods are highly refined, they become very complex, and the necessary auxiliary equipment becomes expensive to the extreme. Photoelectric photometry is done by measuring the electrical output of a light-sensitive device such as a photocell or multiplier phototube, and using this electrical output as an indicator of light brightness. Photoelectric equipment is generally regarded as being complicated and obscure in principle, but a radio amateur would find the electrical part of any photoelectric photometer to be simplicity itself, compared to a radio receiver or transmitter.

Many amateur astronomers are familiar with visual methods of photometry through their affiliation with the AAVSO. Visual methods are well adapted to the use of amateurs because they may be practiced with a minimum of expensive equipment. Photographic methods are not used by amateurs because of the technical difficulties and expense involved, and photoelectric photometry is all but unknown to the amateur for the same reasons. During the last few years, however, there have been developments in this field which may result in the adoption of photoelectric methods by some amateur astronomers.

One may well ask why one should bother with the construction of special equipment for doing photometric work, when it is well known that photometry by the Argelander method requires little more than a telescope and star charts. The answer lies in the precision of the results obtainable. Differences in brightness of approximately 0.1 magnitude can be detected with the eye; thus, photometric observations made with the eye will have an error of about 0.05 magnitude. This is known as a *random error* in the observations. Furthermore, two observers may continually disagree as to the evaluation of a certain photometric estimate; their measures are then said to be affected by a *systematic error*. Of course, all physical measurements are subject to these two kinds of errors. A useful physical measurement is one where these two types of errors are satisfactorily small compared with the size of the quantity being measured. An amateur using visual estimate methods of photometry can therefore make valuable contributions to the photometric study of objects having large variations in brightness, but the field of the photometry of small light variations and the entire field of color measurement are closed to him. An amateur with a photoelectric photometer would know few such limitations, for, within its operating limits, photoelectric photometry has by far the lowest random and systematic errors of any of the methods of photometry.

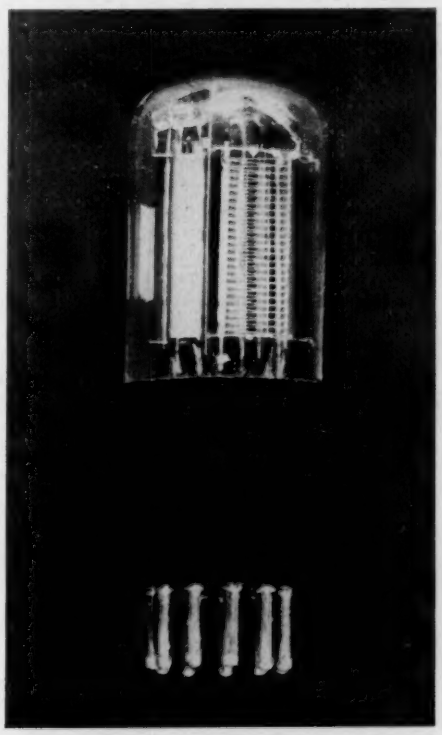


Fig. 1. A 1P21 multiplier phototube (shown actual size), manufactured by the Radio Corporation of America. The tube is the same size as many of the smaller standard radio tubes. The photocurrent is amplified by a factor of between one and five million times inside this small instrument. Photograph by Lick Observatory.

Ten years ago, the statements made above would have been of only academic interest to an amateur astronomer. The equipment necessary for accomplishing photoelectric photometry was so expensive, and so difficult to build and operate, that no amateur could possibly aspire to ownership and use. Today, however, the picture is somewhat different, owing principally to the introduction by the Radio Corporation of America of a remarkable light-sensitive cell known as the 1P21 multiplier phototube (Fig. 1). This is not to say that any amateur astronomer can now whip up a photoelectric photometer by buying a few dollars worth of parts at the corner radio supply store, and putting them together that afternoon. The construction of such an instrument is still a fairly expensive undertaking, and requires many hours of patient, careful work. It seems quite possible, however, that some amateurs will undertake it, and the value of the observations they could make would be immense.

The parts of a photometer fall into two categories: electrical and optical. The electrical parts consist of the multiplier itself, a suitable voltage supply to actuate the multiplier, a meter of some kind for measuring the electrical output of the multiplier, and a means for controlling the sensitivity of the photometer

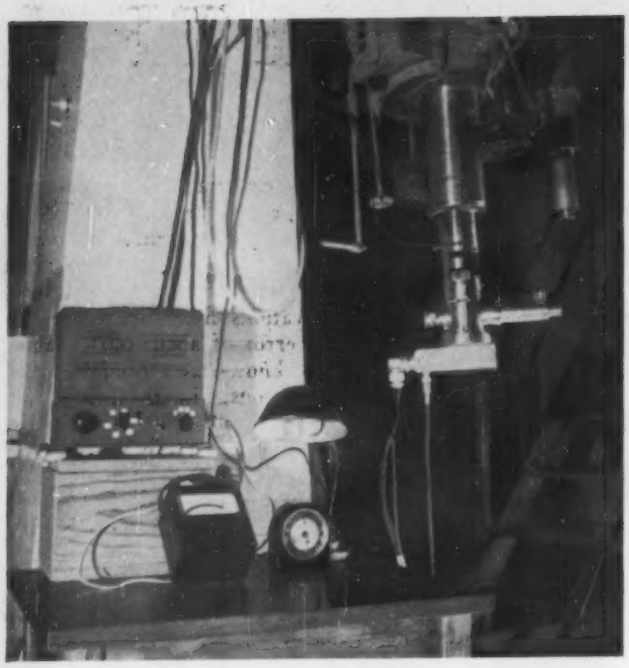


Fig. 2. A complete photometer installation on the Lick Observatory 12-inch refracting telescope. The wooden box on the desk contains the battery voltage supply for the multiplier, and standing on top of the voltage supply is the amplifier. To the left of the clock is a Weston Model 301 meter, which indicates the deflections. The photometer can be seen attached to the telescope at the right of the picture. Lick Observatory photograph.

so as to adapt it to the measurement of light over a wide range of intensity. The measuring instrument may be either a galvanometer or it may be an electric amplifier feeding into a much less sensitive meter than a galvanometer. To an amateur astronomer, the advantages of the latter device are that it is a little less expensive than a galvanometer and it is fully portable. The amplifier type of meter presents additional complication, however, and probably should not be attempted by those unskilled in the use of vacuum tubes. The electrical parts of a galvanometer-equipped photometer cost very approximately 150 dollars at the present time, while the amplifier type is about 20 dollars less expensive. Further reduction in cost of about 40 dollars can be accomplished by substitution of the inferior type 931A multiplier phototube for the 1P21, but there will be an accompanying reduction in the performance of the photometer.

The optical parts of a photometer start, of course, with a telescope. A reflecting telescope is best. It should have a good equatorial mount with a clock drive, and the most convenient focus at which to work is the Cassegrain, because of the relatively small arc through which the photometer will move as the telescope is turned from one object to another. Useful work can be done with a telescope having an aperture as small as six inches, but a 12-inch instrument, or larger, will extend the use of the photometer to fainter objects, and the choice of objects upon which work can be done will be less restricted. The optical properties of the telescope must be good, but it need not be capable of giving the highest type of critical definition. The focal ratio matters very little, as long as it is not much smaller than f/5; the highly convergent beam of smaller focal ratio optical systems causes difficulties in getting all of the light onto the rather small sensitive surface of the multiplier.

The telescope must be equipped with a focal-plane diaphragm of such size that it admits all of the light of the object being studied and a minimum of unwanted skylight. Plainly, such objects as comets, planets, and nebulae will require larger focal-plane diaphragms than stars, so a versatile photometer assembly will be one in which the diaphragm may be changed conveniently. A light-tight container must be made for the multiplier, and this unit, the receiver, must be attached behind the focal-plane diaphragm in such a way that an extra-focal image having a diameter of no more than 0.25 inch falls upon the sensitive surface of the multiplier. Always keep in mind that you are working with an instrument of great sensitivity to light; therefore, there should be no light leaks of any kind. There should be no opportunity for the multiplier to "see" any light except that of the astronomical object whose brightness it will be used to measure, plus a certain amount of unavoidable skylight.

In addition to the receiver and the focal-plane diaphragm, there should be a means for inserting filters of various kinds into the light beam, either in front of or behind the focal plane. They should not be too near the focal plane, because very minute irregularities in the filter, such as a speck of dust or a small defect, will be more serious in a small beam than in a large one. Probably a good rule is to place the filters in front of the focus, and as far in front as the multiplier is placed behind. Last of all, the photometer should be provided with a dark slide. This can be a sliding piece of metal with a hole in it, placed near the focal plane. Exposures may then be made by sliding the dark slide aperture into registration with the light beam.

Guiding on the object being measured can probably best be done by the amateur with his finding telescope. The finder should be of considerable focal length, at least one quarter as long as the main instrument. The finder should be mounted rigidly to the main tube which, needless to say, should be very rigid in itself. The main telescope may be collimated with the finder by placing an eyepiece where the multiplier is to go; the image in the finder and the one of the main telescope may then both be viewed, and the collimation process may be carried out with the orientation adjustments of the finder. Tests should be made by moving the telescope to different objects in the sky, to make sure no appreciable differential flexure exists between the two telescopes. It will be found convenient to fit the finder with a special reticle, consisting of a little circle drawn to such a scale that it is equivalent in diameter to the focal-plane diaphragm. The observer can then set an image in the center of this circle, and can estimate his guiding errors in terms of the focal-plane diaphragm diameter.

Little more need be said here about details of the construction of a photometer. Those seriously interested may write to Dr. Zdenek Kopal, secretary of the Panel on the Orbits of Eclipsing Binaries (of the American section, International Astronomical Union), and ask for a copy of Bulletin No. 4. Dr. Kopal's address is Harvard College Observatory, Cambridge 38, Mass. The bulletin costs $1.50 per copy.

Bulletin No. 4 contains details for construction of a photoelectric photometer, and includes blueprints for mechanical and optical parts. While it is not recommended that an amateur with a reflector follow the blueprints at all closely, since they represent a design for a refractor, the blueprints may serve as a useful guide. Bulletin No. 4 does not contain instructions for making an amplifier type of photometer, but it is the intention of the writer to publish such instructions soon in a place where they will be generally available. A picture of a complete amplifier-multiplier type of photometer attached to a 12-inch refractor is shown in Fig. 2. Fig. 3 is a close-up of the amplifier.

Astronomical photometry is seldom, if ever, acomplished by direct measurement of the light. Instead, the brightness of one object is almost always expressed in terms of the brightness of another, and the photometer, therefore, serves more for comparing two objects than for direct measurement. In order to give a better picture of the methods by which a photometer is used, we shall carry through a sample problem. The star AR Lacertae is an interesting one; it is an eclipsing variable composed of two rather late-type stars. A study of its variations in light will add to our knowledge of the properties of such stars. We look up AR Lacertae in some star catalogue, such as

the *Henry Draper Catalogue,* and find its visual magnitude at maximum light is 6.96, within easy reach of a 12-inch telescope photometer, which should be useful on objects as faint as 10th magnitude. We now turn to the *Bonner Durchmusterung* chart, and find that AR Lacertae is in a field containing several other stars of approximately the same brightness. These stars are identified in the *Henry Draper Catalogue,* and may be tabulated as follows:

a.	AR Lacertae	*G*5, *K*0	6.96 mag.
b.	BD +44°4044	*A*2	6.14
c.	BD +44°4041	*A*0	6.42
d.	BD +44°4043	*K*5	6.50.

We will select a comparison star from among *b, c,* and *d.* The *A*-type stars are hotter and therefore bluer than AR Lacertae; this is a disadvantage, but, on the other hand, *A*-type stars are usually very constant in light. The *K*5 star is about the right color, but it might vary slightly in light.

When night comes, we point our telescope according to the known co-ordinates of the field; we identify AR and the three candidates for a comparison star; and we expose our multiplier to the light of AR first of all. The sensitivity of the photometer is adjusted until we get about 80 per cent of full scale deflection on AR, and then we try the three comparison stars. The first one, *b,* throws the meter off-scale because it is much the brightest of all; *c* also "pins" the meter; *d,* however, because it is quite red, gives a deflection only slightly larger than that of AR. This is such a convenience that we decide to trust in the constancy of light from *d,* and use it for a comparison star, with the intention of changing to one of the others if *d* is found to vary. If it becomes necessary to use one of the brighter stars, its intensity can be reduced by means of a neutral filter placed in the filter holder, for the comparison star alone.

Suppose, however, that we go ahead with *d.* First we measure the sky brightness by setting the telescope to a nearby region clear of stars, and making three 15-second exposures on the sky. To do this, first set the "dark" indication of the meter to a convenient place. Then, making use of an electric clock or watch with a sweep second hand, open the dark slide when the second hand passes a convenient point, and write down the dark reading, or, better, have an assistant make the meter readings while you run the telescope. Fifteen seconds later, read the meter, close the dark slide, and record your meter reading. Make three of these sky readings, maintaining the 15-second intervals, and end the series (called a "set") with a dark reading.

Now move to the comparison star and take a set of four deflections (actually nine meter readings, four "clear" readings, and five "darks"); move then to the variable and take a set of four on it, and so on, back and forth between comparison star and variable. Remember always to record the standard time of the middle reading of each set, to the nearest half minute. The sky may be measured about every half hour or every hour, depending upon how bright it is in comparison to the object being measured, or how rapidly it is varying. Sometimes, during the rising or setting of the moon, it may be necessary to take sky measurements every 10 minutes. When extended objects such as comets are measured with a large-diaphragm aperture that admits a lot of skylight, it may be necessary to measure the sky once for each measurement of the object.

The data must now be *reduced,* that is, the mass of readings must be converted into magnitude differences between the variable and the comparison star. Take the first two dark readings of a set, and find the mean. Subtract this mean from the first slide-open reading. Now find the mean of the next two dark readings (note that one dark is used over), and

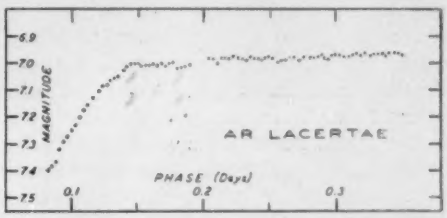


Fig. 4. A portion of the light curve of the eclipsing binary AR Lacertae, determined with the telescope and photometer shown in Fig. 2. The probable error of a single observation is about 0.0037 magnitude, a value for a night of average seeing at Mt. Hamilton. The portion of the curve up to phase 0.15 day is the end of primary minimum. The slight rise of 0.04 magnitude from this point to the end of the curve is caused by the ellipticity of the two component stars making up the binary.

subtract from the second open, and so on until the three or four in the set have been done. Find the mean of all of the deflections for the set. Reduce all of the sets in this way. Now plot the means for the sky sets against time of observation, draw a smooth curve through the points, and read from this curve a value of the sky deflection at the time of each set on the variable and comparison star. Subtract this value from each set, keeping in mind that a neutral filter, if one has been used, reduces the skylight by the same factor as the starlight. Plainly, the chore of applying the sky corrections is very easy when the sky has remained of constant brightness during the observing period.

You now have a series of mean deflections which are proportional to the brightnesses of the two stars being compared, but, since observations of the two could not be made simultaneously, appreciable changes in atmospheric transparency may have occurred during the time between measurements of the variable star and preceding and following measurements of the comparison star. The best that can be done about this is to average two consecutive sets of the comparison star, and to assume that this mean represents the apparent brightness of the comparison star at the time the measurement of the variable was being made. Note that in forming these new averages, each set on the comparison star, with the exception of the first and last, is used twice. You will now have a series of groups of three numbers; the three numbers are the mean deflection on the comparison star, the mean deflection on the variable, and the standard time. The

Fig. 3. A direct-coupled amplifier for use with a multiplier type photometer. This amplifier is small and compact, and it is fitted with sensitivity controls giving it a range of 10 magnitudes by ¼-magnitude steps. The amplifier has a zero-set control, and runs from standard 110-volt AC power. The indicating meter shown in this picture is an inexpensive 0-1 milliammeter. Lick Observatory photo.

ratios of the two mean deflections may be converted into magnitude differences (usually done in the sense comparison minus variable), and these, plotted against time, will show how the star varies during the observing period.

The results of six hours' work on AR Lacertae with the photometer and telescope illustrated in Fig. 2 are plotted in Fig. 4. A complete light curve for AR Lacertae would require about 48 hours of observing. The work would have to be distributed over about four months in order to cover the curve completely (because of the period of nearly two days), and therefore observing would progress at the rate of 12 hours per month. The resulting complete light curve can be used for determining the diameters, masses, and temperatures of the two components, their degree of oblateness, and possibly the degree of limb darkening. In addition, there is always the latent possibility of making a discovery of some previously unknown property, and this can sometimes be very exciting.

The above discussion of the reduction of observations does not mention corrections for differential extinction, or reductions of the times of the observations to heliocentric time. The discussion is therefore incomplete, and is probably confusing as well. The complete reduction of astronomical observations is often complicated, sometimes uninteresting, and usually unfamiliar to amateur astronomers. It is not the intention of this article to attempt the transformation of amateurs into professionals! Those amateurs with notebooks containing reliable photoelectric observations will find no difficulty in getting help with their reductions from observatories engaged in variable star work.

The field of astronomy is full of interesting and valuable problems which can be solved with the aid of a photoelectric photometer. One of the most open fields is the photometry of comets, which cannot be done really well by any other method. The photoelectric cell has the property of measuring the total amount of light that falls upon it, regardless of the geometrical properties of the image; extended or nebulous objects may therefore be measured just as well as stellar ones, providing, of course, that all of the desired light falls upon the cell. Comets and nebulae have always been troublesome objects for photographic and visual photometry, because of the difficulty of interpreting the light of extended objects in terms of the light of stellar comparisons. It has been said by one expert on the properties of comets that the estimated brightnesses of some of them may be in error by as much as two magnitudes, and that the law of variation of comet brightness with distance from the sun has not adequately been tested by observation. A photoelectric study of the brightness of comets would be valuable work for an amateur astronomer.

The period of rotation for several of the planets is unknown. There is a possibility that rotation periods can be determined by photoelectric photometry, by detecting the variation of light caused by surface spots. Venus is not a good object for this, but Neptune would be. The rotational periods of some of the brighter asteroids and satellites of the solar system may possibly also be determined.

Many problems of more direct interest to professional astronomers can be aided greatly by the observations of amateurs. These problems fall into two broad categories: the study of phenomena that happen at very rare intervals, or only once, and the study of phenomena that require continuous observations over extended periods, such as 12 to 18 hours, and therefore must be carried on at more than one site, separated considerably in longitude. Problems of the first type should be studied simultaneously by as many observers as possible, so as to add weight to the results. Stars like the very long-period eclipsing variables Eta and Zeta Aurigae, and all novae fall into this classification. Problems of the second type are sometimes met with during the study of variable stars having periods of between 0.5 and two days; sometimes it becomes necessary to measure such a star uninterruptedly during a single period or a large fraction of a period. This can be done only by having a series of active observatories widely separated in longitude. The value of such an arrangement is also great for studying variable stars whose periods are almost exact small multiples or sub-multiples of a day.

An amateur astronomer with a photometer can find help and guidance from professionals engaged in similar work, if he so desires. Harvard College Observatory, long the headquarters of AAVSO work, will doubtless be as ready to extend a helping hand to amateurs with photocells as to those with only their two eyes and a telescope.

In the *Journal* of the Optical Society of America for June, 1947, Vol. 37, No. 6, there is an excellent technical discussion by Ralph W. Engstrom, RCA, entitled, "Multiplier Photo-Tube Characteristics: Application to Low Light Levels." Additional bibliographic information is given with this article.—ED.

TERMINOLOGY TALKS- J. Hugh Pruett

Distance

How feeble are we earth dwellers in our attempts to visualize even vaguely the enormous distances across the vast universal spaces. We see hills, mountain ranges, and snowy peaks on our world 10, 25, or 100 miles away, but do we adequately sense the reality of even 50 miles? Anything beyond this surely arouses no response in the actual distance perception of most of us — greater distances we accept on faith or reason.

Primitive peoples generally considered the heavenly bodies relatively near. Even some supposedly enlightened persons today wonder if our scientists are not merely guessing at the enormous cosmic expanses. But a few of the ancient Greeks, such as Aristarchus, Eratosthenes, and Hipparchus, were sure even the moon was very far away and made reasonable attempts to measure its distance.

Mean distance

If the value of a quantity varies, its "mean" is usually an average of its several values; the average may be arrived at by a number of methods. But in astronomy, the mean distance of a planet or a satellite in its orbit may be specially defined. For instance, the earth in its annual journey around the sun does not travel in a circle but in an ellipse — an oval-shaped figure. On its elliptical orbit, the earth is not always at the same distance from the sun — its distance changes from a maximum in July of about 94,600,000 miles to a minimum in January of 91,400,000 miles. The average of these is 93,000,000, which is the earth's mean distance.

In any closed orbit, the mean distance is defined as half the length of the major axis, which is the longest axis of the ellipse, and joins the points of minimum (perihelion) and maximum (aphelion) distances of the planet from the sun. Similar definitions and terms apply to the orbits of satellites, double stars, and other celestial bodies.

Mile

The smaller celestial measurements are quite conveniently expressed in the common terrestrial unit, the mile. The distance above the earth's surface to luminous meteors is less than 100 miles; and the mean distance to the moon about 239,000 miles. But the mean distance from the sun to the earth is 93,000,000 miles; to the most remote planet (Pluto), almost 4,000,000,000 miles; and to the nearest known star (Alpha Centauri), over 25,000,000,000,000 miles. We note that these five numbers are respectively expressed in hundreds, thousands, millions, billions, and trillions of miles.

Astronomical Unit

In order to simplify the numerical part of expressions of measurement and to compare more easily the distances of the various members of the solar system, there is generally employed a unit much larger than the mile, in fact, 93,000,000 times larger. This is the astronomical unit, abbreviated A.U., or the mean distance from the earth to the sun. It might seem more reasonable to use the distance from the sun to the planet

(Continued on page 13)

Amateur Astronomers

North Central Region of AAL Is Organized

THE FIRST CONVENTION of the North Central region of the Amateur Astronomers League took place Saturday, August 30th, at Duluth, Minn. The Darling Astronomy Club was the host society.

After open house at the Darling Observatory on Friday evening, the first session was held Saturday morning under the chairmanship of Dr. C. M. Huffer, of the Madison Astronomical Society. H. B. Porterfield, of Madison, presented a constitution patterned after the by-laws of the national organization. The regional council consists of the regional officers, one representative from each member organization (holding office for three years in a staggered manner), and a member-at-large.

Terms for the first council members were decided by lot: *Three years*: Burnham A. S., Chicago; Darling A. S.; a member-at-large. *Two years*: Madison A. S.; Milwaukee A. S.; Popular Ast. Club, Moline, Ill. *One year*: Joliet A. S.; Wichita A. S. These are the seven present organization members in the North Central region, which contains Illinois, Iowa, Kansas, Minnesota, Missouri, Nebraska, North and South Dakota, Wisconsin, and the upper peninsula of Michigan.

The astronomical exhibits, set up in a dining room of the Duluth Chamber of Commerce, included both reflecting and refracting telescopes, tubes, mountings, an aurora camera, and various photographs. After dinner, the 35 persons present went by bus to the Duluth Teachers College, where, in a session open to the public, Dr. Huffer introduced Congressman Anderson, of Duluth, who welcomed the league.

Then Dr. Otto Struve, of Yerkes Observatory, spoke on the new accomplishments in astrophysics. He told of the measurement of stellar rotation by the Zeeman effect; of the determination of the inclinations of eclipsing binary orbits by means of polarized light; of the negative hydrogen ion on the sun and other stars; of cosmic static observed by large radio antennae, and of solar spectra in the far ultraviolet from V-2 rockets.

Later that afternoon the new by-laws were adopted, with each member society made eligible to cast, at a regional convention, twice the number of votes as it had at the previous national convention. Dr. Huffer was unanimously elected regional chairman; Neil Lockwood, of Duluth, vice-chairman; and Miss E. Wight, of Milwaukee, secretary-treasurer.

After dinner, there were talks by the members on the work of the various represented societies. Edward A. Halbach, whose induction as national president of the league took place during this convention, gave a talk on the aurora borealis and asked for co-operation among the societies in observing this phenomenon. Frank Halstead, president of the Darling Astronomy Club, discussed junior astronomy, and two young members of school clubs in Duluth told of their experiences. Dr. Huffer talked on meteors, describing work by the Madison group using radio and plotting from two stations.

The Milwaukee Astronomical Society will be host to the 1948 national convention of the league, and the regional convention will be held concurrently. Start planning your 1948 vacation for the 4th of July weekend and attend this event in Milwaukee.

W. B. Albrecht
Milwaukee Astronomical Society

The Duluth regional convention. Photograph by W. B. Albrecht.

THIS MONTH'S MEETINGS

Chicago: The Burnham Astronomical Society will meet on Tuesday, October 14th, at 8 o'clock in the Chicago Academy of Sciences Auditorium. "Astronomical Facts and Fancies" will be discussed by Professor Robert L. Price, of Joliet Junior College.

Cincinnati: Dean George B. Barbour, professor of geology at the University of Cincinnati, will speak at the October 10th meeting of the Cincinnati Astronomical Association. His subject is to be announced. The meeting place is the University of Cincinnati campus.

Geneva, Ill.: The annual banquet of the Fox Valley Astronomical Society will be held at the Baker Hotel, St. Charles, on Saturday, October 25th, at 7 p.m.

Indianapolis: At the October 5th meeting of the Indiana Astronomical Society, at Odeon Hall, 2:15 p.m., W. G. Gingery will speak on "Teaching Astronomy."

Kalamazoo: "Eta Aquilae" will be discussed by Dr. L. N. Upjohn at the October 11th meeting of the Kalamazoo Amateur Astronomy Association, at Dr. Upjohn's home, 1556 Long Road.

New York: "The Work of the AAVSO Solar Division" will be the topic of discussion by Neal J. Heines, solar division chairman, at the meeting of the Junior Astronomy Club on Saturday, October 18th, at the American Museum of Natural History.

"Mars, the Mysterious Planet," will be the subject of the discussion by Dr. Clyde Fisher, of the Hayden Planetarium, speaking to the Amateur Astronomers Association at its October 1st meeting. The lecture is at 8 p.m. in the American Museum of Natural History.

Pittsburgh: Cliff Raible, a member of the Amateur Astronomers Association of Pittsburgh, will unveil his model of the 200-inch telescope at the October 10th meeting of that society. He will be principal speaker, and will give details on the construction of the model, as well as an explanation of its working parts. The meeting begins at 8 p.m. in the Buhl Planetarium.

Washington, D. C.: Dr. Grote Reber, of the Central Radio Propagation Laboratory, National Bureau of Standards, will be the speaker at the meeting of the National Capital Astronomers on Saturday, October 4th, at 8 p.m., in the National Museum. The subject of his lecture will be "Galactic and Solar Radio Waves."

"Enjoy the Stars"

Entering its 21st season, the Amateur Astronomers Association, with headquarters in New York's American Museum of Natural History, announces its 1947-48 program and classes in the annual pamphlet, "Enjoy the Stars." Among types of membership in the AAA is a recently established foreign membership class. The society, which now has over 600 members, numbers among its activities an astronomical news service.

An innovation in the class schedule of the association is home study, whereby

(Continued on page 15)

DÜRER AND EARLY STAR MAPS

By Samuel G. Barton, *University of Pennsylvania*

PART II

NEITHER DÜRER nor his maps are mentioned in Basil J. W. Brown's *Astronomical Atlases, Maps and Charts* (1932), where one would surely expect to find a reference to them. On the other hand, Brown states that "the earliest actual map of the heavens, with figures of the constellations shown and the stars of each group marked with any precision, appears to be that of Peter Apian." He reproduces this map, which is definitely dated August 5, 1536, and states that it is most certainly the original of the woodcut of Ostendorf. Now, of course, Apian's map is subsequent to Dürer's. Inspection shows that it closely resembles Dürer's as to the constellation figures, although there are a few minor but interesting differences. Brown, on page 16, states: "There is no general agreement between the constellation figures of Apian and those given nearly a century later in Bayer's *Uranometria.*" I concur in this opinion but some others, as noted last month, in writing of Dürer's figures, which are so much like Apian's, express a different opinion.

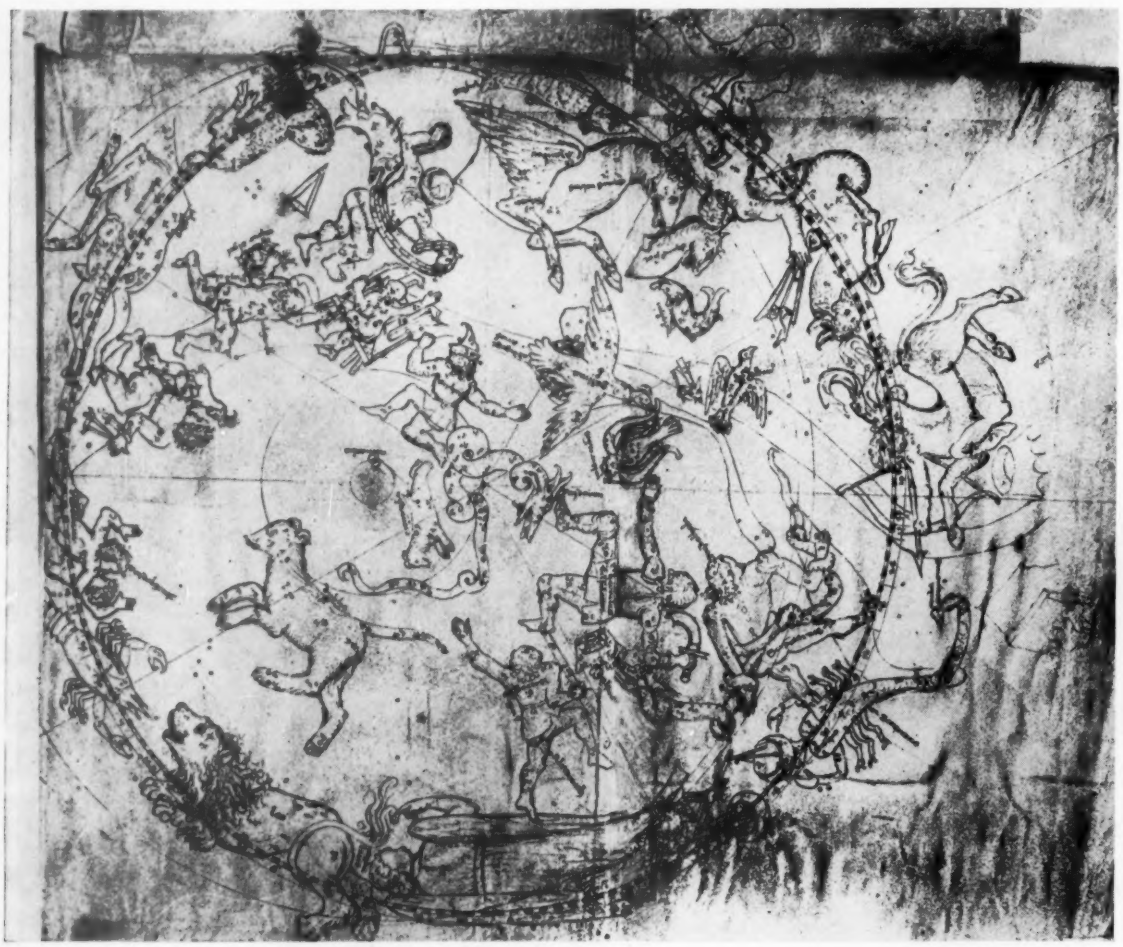
Changes in Apian's map from the earlier Dürer chart are the inclusion of the name Crines Berenices (but no figure) for Coma Berenices; the representation of three dogs with Boötes, whereas we now know two such dogs as Canes Venatici; putting a robe on Cepheus and altering his headgear. Both represent Cancer as a lobster. Apian shows a pretty girl swimming in the river Eridanus. He omits the numbers on the stars given by Dürer, but, on the other hand, inserts some individual star names.

Apian's map by its superscription seems to indicate that he had regard for Dürer's figures. However, he put all the constellations on one map and thus introduced, or rather restored, very great distortion in the southern constellations, discarding the advance made by using two hemispheres.

And while we may have established that Dürer was not the source of much subsequent map-making, except for Peter Apian, it is also becoming increasingly clear that there was, in fact, very little which was original with Dürer. (Dr. Peters names five figures as original with Dürer; what he considers to be the source of the others is not clear.) This has been established by Dr. Fritz Saxl, who discovered two celestial maps in a manuscript known as Codex Vindobonensis 5415, sometimes referred to as the Vienna maps. They are discussed in an article entitled "Classical Mythology in Mediaeval Art," by Erwin Panofsky and Fritz Saxl, in *Metropolitan Museum Studies,* Vol. 4, part II, March, 1933 (also published as a reprint). Much interesting information is to be found there. Additional material is contained in Dr. Saxl's *Verzeichniss,* part 2, listed on page 280 of the above reference. The reproductions of the Vienna maps given here are from this *Verzeichniss.* I am indebted to these sources for information. These maps, and Dürer's as well, I believe are quite unfamiliar to astronomers.

The maps, which are about 11 by 15 inches in size, are the oldest comparable maps of the celestial sphere thus far published, while the 1515 maps are the first printed maps. Dürer transformed the Vienna maps in his style and removed the optical asymmetry from the northern map by adding the portraits in the corners, thus giving the sheet a significance and a stimulus otherwise lacking.

The stars on Dürer's map, as on the



The earliest known map of the northern sky, dated about 1440 A.D. This is one of the so-called Vienna maps, reproduced from cod. Vind. 5415, via "Verzeichniss," part 2. This and the map opposite may be based on the lost chart of Regiomontanus, 1424 A. D.

earlier ones, are assigned the numbers given them in Ptolemy's star catalogue. After such maps were made it was no longer necessary to refer to particular stars by stating their positions in the creatures or objects represented. The numbers increase in general from the head to the feet or tail, but not always, as we may note in Cepheus, Fera (Lupus), or Ursa Minor. This precedent probably influenced Bayer in his assignment of Greek letters.

Another fully illustrated article on the general subject has been published very recently by W. Voss in *Jahrbuch der Preussischen Kunstsammlungen,* Vol. 64, pages 89-150. It is dated 1943 but did not appear until October, 1944. It announces the discovery of another star map made at Nuremberg, dated 1503, also having three authors, Heinfogel, Ulsen, and Sperancius. It will be noted that Heinfogel was a common author of this map and that of 1515, and probably is the one to whom most credit should be given, although Dürer's name alone is usually attached to that of 1515, because of his fame.

Dr. E. Panofsky, of the Institute for Advanced Study, at Princeton, kindly called the Voss article to my attention and lent me a copy. With his permission I give his summary of its contents:

"I should like to say that the article suffers somewhat from the fact that the author, by his own admission, did not become acquainted with Dr. Saxl's publication on the maps in cod. Vind. 5415 until after he had completed his own essay. Consequently, the whole situation does not appear very clearly. So far as I can see it may be summed up as follows: The archetype of the whole group of maps would be the map as of 1424, supposedly owned by Regiomontanus, now lost. The [Vienna] map in cod. Vind. 5415, datable about 1440, seems to be a fairly literal copy of this lost original. The map of 1503, discovered by Mr. Voss, is based either upon the 'Regiomontanus map' or upon the Vienna copy: the latter possibility, not envisaged by Mr. Voss, cannot be dismissed inasmuch as the map of 1503, although doubtless produced in Nuremberg, was executed for a Vienna group of scholars who may have furnished the material; this question must remain open as long as the 'Regiomontanus map' is not available for comparison. Dürer's woodcuts are directly based upon the map of 1503. The positions of the stars — but in this respect I have to trust the statement of Mr. Voss — are those of 1424 in the Vienna map as well as in the map of 1503. It was only in Dürer's woodcuts that the positions were brought up to the epoch of 1499 or 1500. The humanistic modernization of the images and nomenclature, however, thus far attributed to Dürer, was already performed by the anonymous author of the map of 1503."

The earliest known map of the southern sky, reproduced from cod. Vind. 5415, via "Verzeichniss," part 2. The blank area was invisible from northern latitudes.

The Nuremberg (1503) charts are parchment sheets about 25 inches square, with the ecliptic circle about 19 inches in diameter. Exquisitely executed designs occupy the corners and edges. In the corners of the northern chart among other things are represented the four elements, earth, fire, air, and water, also figures of Apollo (Sun), Luna (Moon), and the planets Mercury, Venus, Mars, Jupiter, and Saturn. The southern map has a circle of 12 windheads, that is, heads pictured blowing winds from the mouth, and has various other figures and inscriptions not easily described. Some details of the drawings may be by Dürer.

TERMINOLOGY TALKS

(Continued from page 10)

nearest to it, Mercury, as the basis for this unit, but since we are riders of the earth, we naturally vote our world first place.

The distance from the sun to Mercury thus becomes 0.387 A.U.; to the earth, 1.00 A.U.; to Pluto, 39.5 A.U.; and to the nearest star, about 270,000 A.U.

Light-year

If we travel among the planets, we may express our distances anywhere in small numbers of astronomical units. But out among the stars we must greatly increase the length of our tapeline, or else waste too much time stretching it from one celestial stake to the next. For this purpose we use the light-year.

We shall not derive much help from the definition recently given by a University of Oregon student, who tried this as a possible grade booster: "The light-year is very, very much longer than the ordinary year." Of course, the light-year is not a unit of time at all, but one of distance. Simply defined, it is the distance that light can travel in one year as it dashes through space at its accustomed speed of 186,270 miles per second. Determine the number of seconds in a year, multiply this by the speed of light, and the result is approximately 5,880,000,000,000 miles. For easy remembering, we say six trillion (or six million million) miles. Those who have a flair for figuring may want to show that the number of astronomical units in a light-year is very nearly the same as the number of inches in a mile.

A somewhat larger unit than the light-year is the parsec. This will be explained after we discuss parallax in a future issue.

Bayer's representation of Cetus, prominent fall constellation. Mira is labeled as Omicron Ceti, near the nape of the monster's neck. In the lower left is the great curve of Eridanus, the River.

FALL

By Robert R. [illegible]

THE SEASON of the harvest and hunter's moons holds a peculiar fascination that is hard to resist. There is the pleasant aroma of burning leaves in the atmosphere, and a symphony of autumn insects at night. Overhead is an ever-changing panorama set with dozens of scintillating gems. The summer constellations are disappearing in the west, and as the lengthening nights and falling temperatures announce the advancing season we look to the east for the arrival of the autumn stars.

But even long before Sagittarius has begun to set in the southwest, the vanguards of the autumn sky parade have advanced to the meridian. High overhead, to the west of the meridian, the famous Northern Cross, part of the constellation of Cygnus, appears embedded in the Milky Way. This group belongs to both summer and autumn skies. It remains conspicuously visible during the early evening hours until winter sets in. At Christmas, the cross may be found standing upright on the northwestern horizon just after dark comes each evening.

In the vicinity of the Northern Cross are to be found many interesting objects. Among them is the star 61 Cygni, the first whose distance was measured. by the German astronomer, Bessel, in 1838. For several years thereafter, this 6th-magnitude double star, at a distance of about 11 light-years, was thought to be the nearest beyond the sun, but today there are almost a dozen known to be nearer.

There are numerous nebulosities in Cygnus, including the famous Veil or Network nebula, the North America nebula, and the Pelican nebula. Through this region the Milky Way is divided by dark lanes made up of obscuring matter that hides the light of the more distant stars.

At the foot of the Northern Cross is a 3rd-magnitude star, Albireo, the Beta of the constellation, which in a small telescope appears to be a double star — for there are two stars in the field, of beautifully contrasting blue and gold colors. Deneb, at the top of the Cross, is a giant sun some 400 light-years from us. Its visual magnitude is 1.33.

At about 9 o'clock, local time, the zodiacal constellations of Sagittarius, Capricornus, Aquarius, Pisces, Aries, and Taurus span the sky from southwest to northeast. Of these, the most conspicuous groups are Sagittarius and Taurus. The others, though less striking in appearance, are of interest too. These constellations are all famous, of course, because they mark the apparent paths of the sun, moon, and planets. They are mileposts on a celestial highway, and are among the most ancient of the constellations.

In Pisces, the Fishes, is the vernal equinox, that place on the celestial sphere where the sun crosses the celestial equator on its journey north early in the year. And although the vernal equinox gradually shifts its position westward it always remains among the constellations of the zodiac. Thus, although the effect known as precession changes the position of the celestial poles among the stars, the ecliptic, baseline of the zodiac, is relatively fixed, and the zodiacal constellations always remain the same.

Alpha Capricorni is a famous naked-eye double star, which is a telescopic double-double. Beta Capricorni is a double star in binoculars, the stars' separation being about the same as that of the well-known Epsilon Lyrae. Olcott lists the stars Omicron, Pi, Rho, and Sigma Capricorni as doubles, also.

Aquarius contains the famous asterism of the Water Jar, situated directly on the celestial equator. This large constellation contains many double stars, and there are streams of faint stars easily seen with the naked eye. More double stars are to be found in Pisces, with Al Rischa, the knot which ties the fishes together, itself a telescopic pair. The Circlet (of the western fish) is a group of seven naked-eye stars.

Aries contained the equinox thousands of years ago, so its symbol is still used to mark the vernal equinox on charts and diagrams. It has three principal stars near together, Hamal, the brightest, being of the 2nd magnitude.

SADALMELIK

Faint star gleaming in the sky,
They call you Sadalmelik, whose name doth sig[n]
"The Lucky One." I wonder why.
Art thou luckier than I?

Compared with mine, your riches may be few.
I have the love of a family, a few friends true
There's the knowledge of the sages for me to p[u]sue.

Mine is the pleasure of sunsets, and awakening trees,
The pattering raindrops, and music of the bre[e]
What wealth of yours compares with these?

Oh faint star twinkling through the night,
Sending forth your feeble light,
They call you Sadalmelik. I know not why.
Could not Sadalmelik be I?

D. B. H[o]ert

SKIES

ES, *Hayden Planetarium*

The constellation of Pegasus, the Winged Horse, is approaching the meridian these early October evenings, followed by Andromeda. The Great Square of Pegasus is a sight familiar to all celestial navigators, and Andromeda is famous largely because it contains the Great Nebula, known as Messier 31. This appears to the naked eye as a rather indistinct blob of light some eight degrees northwest of Mirach (Beta Andromedae). For the novice it may not be easy to see, and even after it is pointed out it does not look like much.

But when we are told that this little insignificant-appearing object is in reality another universe of stars, it begins to take on added interest. Telescopes and cameras reveal it as a huge spiral galaxy composed of millions of individual stars. And its distance makes it a sight worthy of our attention. It is some 750,000 light-years away. Here we are looking out beyond the stars on the fringe of our own Milky Way galaxy, and at the same time we are searching back through three quarters of a million years. Discovery of the Great Nebula in Andromeda is one of the thrills that await the explorer of our autumn skies.

At about 8 o'clock, the star Mira (Omicron Ceti) rises in the east. This long-period variable is the principal object of interest in the constellation of Cetus, the Whale. It was discovered in 1596, and has long been known as the "wonder star." In November, 1779, it appeared as bright as magnitude 1.5, but its average maximum brilliance is about 3.5. It has faded at minimum brightness to magnitude 10 or even dimmer. Its average period is about 330 days. This is the time that elapses between successive maxima or minima. Last year, about December 6th, it reached a magnitude of 4.3. This month is a fine time to look for it because it is due at its next maximum about October 22nd, but this date is only approximate. Apparently, Mira's changes in magnitude result from pulsations within the star itself. These take place on an enormous scale, for the star has a diameter more than 300 times that of the sun. Is it surprising that we call Mira the "wonder star"?

The sky picture changes rapidly throughout the night. By midnight, many of the autumn groups have shifted well into the western sky, and the constellations of winter have begun to appear in the east. The most famous of these is Orion, which has just about risen at that time. An hour and a half later Sirius rises in the southeast, and the winter stars take over the entire eastern sky.

The zodiacal groups change, too. Sagittarius has set and Gemini is well above the horizon north of east, by midnight on October 1st. This brings the planets which are conspicuous this month into view. Mars, in Cancer, rises shortly after midnight, followed by Saturn. Keeping track of the planets is an interesting adventure for the sky explorer. More details concerning them are given on the Observer's Page.

It is well to remember that the stars rise about four minutes earlier each night, and by the end of October Mira, for instance, will be appearing around 6 o'clock, two hours earlier than it did at the beginning of the month. Also, Orion will be fully above the horizon at 10 o'clock on November 1st.

If you are looking for adventure, try exploring the sky. See if you can find the constellations of the zodiac, look for the Great Nebula in Andromeda, and watch for the return of Mars to the evening sky. It is hard to exhaust all the wonders that are to be found in the night skies throughout the seasons.

The Great Square of Pegasus dominates the sky of mid-autumn, and leads the way to Andromeda, Pisces, Aries, and Triangulum.

A portion of a patrol-camera plate of the Northern Cross, with 61 Cygni marked by a circle.

The time to begin is on the next clear night. Your own backyard or roof is the best location. Use a star chart, and learn your way about the heavens from sunset to dawn and from January to December.

AMATEUR ASTRONOMERS

(Continued from page 11)

members unable to attend regularly scheduled classes may obtain, by mail, suggestions for reading on general topics and specific problems. Information on arrangements and fees may be obtained from the home study counselor, Miss Aileen A. Pindar.

Telescope making classes at the Optical Division workshop in the Hayden Planetarium are scheduled for Tuesday, Wednesday, and Thursday evenings, each course consisting of 25 sessions. Instructors are Stanley Brower, Earle B. Brown, Walter Howland, Richard S. Luce, Alex A. Singer, and Allyn J. Thompson. Outdoor observation meetings are planned the third Wednesday of each month, weather permitting. Six regular weekly courses start October 6th. Information may be obtained from the AAA secretary, George V. Plachy, at the American Museum of Natural History, New York 24, N. Y.

Appreciation of Astronomy, Edgar M. Paulton, 2nd and 4th Wednesdays.

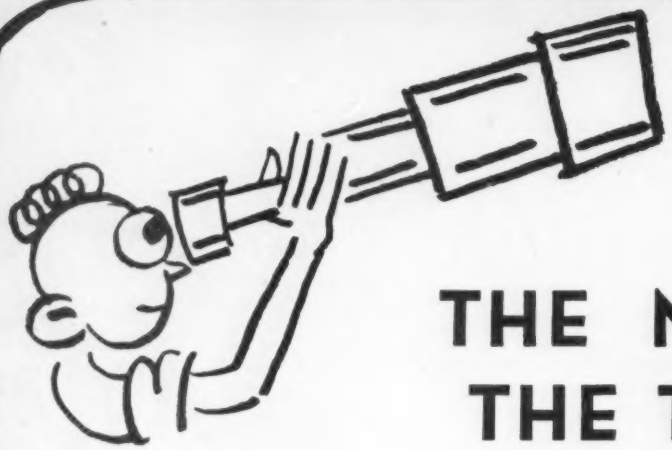
Elementary Astronomy, Richard S. Dodson, Jr., Fridays.

Intermediate Astronomy, W. Wallace Benjamin, Mondays.

Advanced Astronomy (seminar), Leon E. Gold, chairman, Fridays.

Mathematics Survey, Samuel C. Silver, Thursdays.

Mathematical Astronomy, Max Trupin, Tuesdays.



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BOOKS AND THE SKY

HENRY THE NAVIGATOR

Elaine Sanceau. W. W. Norton and Co., Inc., New York, 1947. 318 pages. $3.50.

HENRY THE NAVIGATOR has been called the great pioneer explorer, the man who transferred the art of seamanship from sheer guesswork and reckless adventure to sound principles of celestial navigation on charted seas. Columbus laid the plans for his epoch-making voyages directly on information furnished earlier by the Portuguese prince while his celebrated contemporary, Vasco da Gama, on his voyage to India merely carried the prince's theories through to their logical conclusion. At the start of their careers, apparently, neither of these two great explorers knew any more than Henry had already demonstrated and made known earlier in the century.

Perhaps Henry's reputation as the "Great Navigator" could be disputed. Certainly he sailed on none of the actual voyages of exploration himself, and how much, if any, of the study and research at Sagres may be attributed to him has never been established. Yet all the credit which has been his traditional due is eminently deserved. He alone was the great force behind all that his captains achieved. He provided the inspiration, the enthusiasm, the energy, the information — and the money. He selected his own captains, supervised the fitting out of the ships, laid their courses, and richly and gratefully rewarded everyone upon his return. And when, through superstition, fear, or prejudice, the results were disappointing — as was so often the case — he tirelessly encouraged a return trip, always with the relentless order to "Go farther!"

His well-known school of navigation and astronomy for pilots at Sagres was not a school in the narrow sense, but more "like a congress of experts in constant session." Sagres, which Henry acquired as a barren bluff near the embarkation port of Lagos and built up himself, became the prime interest of his life. In fact, in later years, when his brothers and nephews seethed with medieval intrigue and battered Portugal with their shameless pursuit of power, it served as a welcome refuge, his only escape from the vicious turmoils of court.

It was at Sagres that the great advance in navigation was made. Previously, navigation had been mostly a matter of clinging to the coast and charting a course based on prominent landmarks. To Henry and his scholars at Sagres goes the credit of utilizing the compass, the quadrant, and the astrolabe to emancipate the sailor from the land and to develop thereby the rudiments of celestial navigation.

For those who like their biographies served up in a consciously romantic manner full of vivid recreations of scenes and possible conversations, **Henry the Navigator** should be a welcome book. Those, however, who prefer a more sober, businesslike treatment will doubtless feel genuine regret that Miss Sanceau's evident scholarship and impressive command of facts have been frittered away on so much implausible drama and that the actual vital work at Sagres is hardly mentioned at all.

E. P. STREETER
Cambridge, Mass.

NEW BOOKS RECEIVED

TIME, KNOWLEDGE, AND THE NEBULAE, *Martin Johnson*, 1947, *Dover*. 189 pages. $2.75.

An introduction to the meanings of time in physics, astronomy, and philosophy, and the relativities of Einstein and of Milne.

THE STRANGE STORY OF THE QUANTUM, *Banesh Hoffmann*, 1947, *Harper*. 239 pages. $3.00.

The story of the rise of the quantum to a dominant position in modern science, told in language the intelligent layman may easily comprehend, by a Queens College teacher formerly with the Institute for Advanced Study at Princeton.

MATTER AND LIGHT
The New Physics

Louis de Broglie. Dover Publications, New York, 1946. 300 pages. $2.75.

STUDENTS of physics quickly learn that no one investigator is responsible for each of the great advances which have been made in this science. Men such as Bohr, Fermi, Dirac, Heisenberg, Einstein, Planck, and the writer of this book, have added one or more significant bits to the general pattern of experimentation in the laboratory or in the theories on which our concepts of the universe are based. Although Louis de Broglie has himself won the Nobel prize in physics for his contributions, every page of his book contains adequate evidence that the synthesis of science is achieved only by the efforts of many minds.

Matter and radiation together form the substance of which we conceive the universe to be made, and from early days men have sought to learn how the energy that is radiation is released from and associated with the appearance that is matter. This book by the famous French scientist, translated by W. H. Johnston, goes far toward clearing up the cobwebs in the mental attics where one has stored an accumulation of knowledge and impressions concerning the nature of light and modern theories with such names as wave mechanics and quantum physics.

The approach is not entirely non-technical, as two chapters, which may be skipped, are mathematical, and the thoughts expressed in the others are best understood by those who took their high-school and college physics seriously, or wish to do so now. Perhaps the greatest concept to be gained or cleared up is that by which modern physicists attribute to particles of matter and of radiation the properties both of waves and of corpuscles, thereby easing (though not entirely solving) a problem which has been very troublesome since the days of Newton and his corpuscular theory of light.

At the beginning of a chapter entitled "The Passage of Electrically Charged Corpuscles Through Potential Barriers," a topic of importance in the understanding of nuclear fission, the author says:

"It is a subject that provides a good illustration of the methods of Wave Mechanics, and it shows how thoroughly the problems of the dynamics of electrons have been transformed into problems closely resembling those of classical optics."

The translator notes that the chapter on "The Undulatory Aspects of the Electron" has the special historical interest of having been given as a lecture on the occasion of the author's receipt of the Nobel prize.

In general, the book is divided into six sections, some of them partly repetitious, which the author explains enables each part to be read independently of the others. The titles of these may assist the prospective reader in determining whether or not the book would be of use to him: I. A General Survey of Present-day Physics. II. Matter and Electricity. III. Light and Radiation. IV. Wave Mechanics. V. Philosophical Studies on Quantum Physics. VI. Philosophical Studies on Various Subjects.

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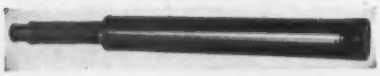

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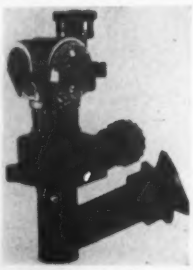

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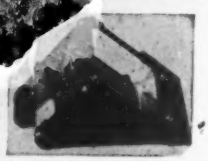

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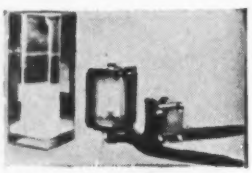

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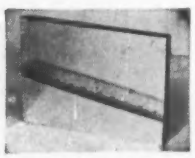

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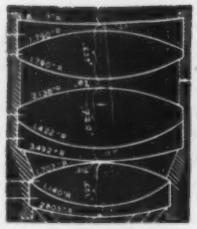

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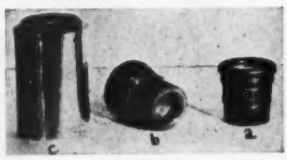

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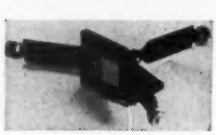
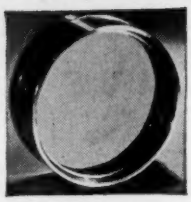


Prism in metal spider mount to fit 5-6-7-8" tube. Light flint glass, fluoride coated, 1¼" x 1¼" face. Connecting arms present thin edges to path of light. Prism centering easily adjusted to slight differences of tube diameter by screws and lock washers. Complete — **$7.00** plus postage. Specify your tube size.



3" Achromatic Lens

Harry Ross Series of "Doublestar" Refractors, 3" aperture (75mm), 40" focal length (1000mm). An air spaced lens, strain free mounted in a smooth aluminum finished satin-black barrel. This lens is an exclusive Harry Ross product. It has a money back guarantee which states, "This lens will meet any and every test you may devise for it as an astronomical objective." It is 20 years since a lens of this quality has been available. Our production is limited. Order early. Postpaid **$60.00.**

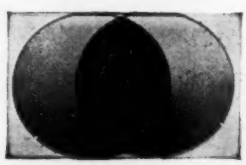
Achromatic Telescope Objectives in all sizes up to 6" diameter to order. Same optical guarantee as with our 3" lens. Write us.

Focusing Mechanism

For Standard 1¼" Eyepiece

Full 2" of focusing motion. One revolution of knurled knob produces ¼" motion on optical axis. Absolute centering guaranteed. No play. Will not bind or lock. No rack and pinion to strip. Precision turned ways allow smooth, easy positive focusing. Adapted to every type of telescope construction. Highest precision, perfect workmanship. Of brass and bronze throughout. Weight 1¼ lbs. **$22.50.**

FOR REFLECTORS — Concave flanged bushing can be supplied to fit the size of your tube. Give telescope tube diameter when ordering. Bushing extra **$10.00.**



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Genuine Polaroid mounted in optical glass. 3" (72mm.) discs perfect for every use in photography, physics, petrology, chemistry, etc. **$1.25** each or 2 for **$2.00** postpaid. Also 1" (25 mm.) diameter **$.60** each or 2 for **$1.00.**

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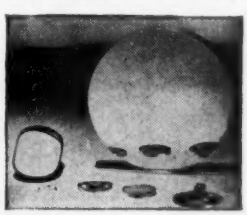
Complete in mounts, ready to snap on the objective of any standard 7 x 50 or 6 x 30 binocular. Photo #88. Extremely interesting photographic possibilities. All light operated electronic relay problems solved with this filter. Make your own "Sniperscope" from filters originally made by government for this purpose. Finest optical glass, mounted. Set **$1.00.**

TELESCOPE KIT



Make a high power reflecting telescope fully finished of precision optical parts, complete kit: 3" diameter, 39" f.l., mirror and diagonal both hard aluminized, plus 3 lenses for high power eyepieces. All **$6.00.**

FREE with any purchase from this ad amounting to $25.00 or more a cloth-bound copy of Allyn J. Thompson's new and popular 211-page volume — "Making Your Own Telescope." A profusely illustrated guide to the practical and economical construction of a reflecting type astronomical telescope.

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Scientific and Laboratory Apparatus

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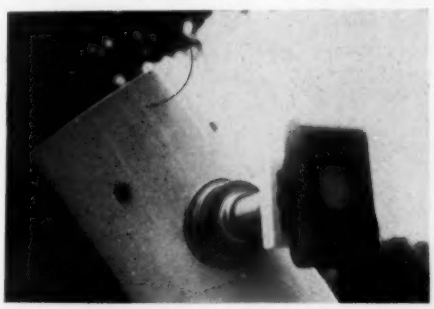
EDITED BY EARLE B. BROWN

SIMPLE ATTACHMENTS FOR SOLAR PHOTOGRAPHY

WHEN the sunspot of February, 1946, made its appearance, I was polishing my second mirror and observing the Orion nebula with my first. In trying to project the sun's image with the telescope in use, I set fire to the front of the tube, and then decided to build the second telescope expressly for solar observation, and I now use two methods for solar photography.

The telescope is a 6-inch reflector. To cut down heat and light as much as possible, the mirror is unsilvered and the prism is turned so the square face is presented to the front of the tube. Light from the mirror strikes the hypotenuse first, and this reflects only about 1/20 of the incident light. The intensity of the original sunlight is cut to about 1/600 by the two reflections, and glass from welder's goggles tones it down further to the correct brightness.

The first method employs two Donald Duck cameras. They are of the inexpensive candid type, taking 12 pictures 1⅝" square on a roll of 127 film. The lenses are removed from both cameras, and one is converted to a dummy camera by the removal of its shutter and the cutting



The dummy camera, with the sun's image focused on the ground glass.

away of part of the back to receive ground glass.

An adapter, consisting of molding to grip the front of the cameras and a clamp to hold the eyepiece and drawtube, is slipped over the drawtube. A red photographic filter is inserted in the tube in front of the eyepiece. After pointing the telescope toward the sun, the dummy camera is inserted in the adapter, and final focus and aim are effected. The live camera is quickly exchanged for the dummy and its shutter snapped; the change is made in about three seconds.

Afterward, the negative is numbered by a device consisting of a box with a lens in one end and an opening in the corner of the other. The distance from lens to aperture is most easily determined by means of the dummy, the object being to have the image of the window in the plane of the ground glass. A celluloid disk numbered around the edge is mounted so that any number may be rotated in front of the window. The camera sits over the lens, and when the shutter is snapped the image of the window with the number in it is projected on the film. The interior of the box is dead black so that light will not reach the center of the film.

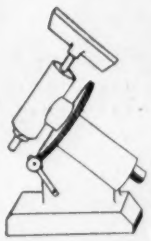
The advantage of this two-camera method is that the films may be developed by the corner drugstore. No darkroom work need be done. When it is realized how closely consecutive pictures resemble each other, the reason for numbering each print becomes apparent. Any eyepiece used with the telescope may be used with the camera. High-power pictures covering a limited region may be made. When a high-power eyepiece is used with the Donald Duck camera, the light is dimmed and a filter of higher transmission than the red should therefore be employed.

The second method utilizes cut film and the shutter previously removed from the dummy camera. As seen in the illustration, the camera body is a plywood box with a door in one side and a bottom curved to fit the telescope tube. The eyepiece and drawtube extend through the bottom of the camera. The top is open and has guides for the cut-film holder and the ground glass.

The shutter is mounted on a shelf attached to the door on the camera. Fastened to the under side of this plywood shelf is an orange filter. Normally, the door is closed and the shutter intercepts the

EQUATORIAL MOUNTING

Complete with slow motion worm and gear.



Heavy cast iron base, 1¼" polar axis — $40 up. Descriptive literature on request.

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Cerium oxide and 2 eyepiece lenses with every kit. Complete with glass tool, 5 abrasives, rouge, pitch, and aluminized diagonal. 4" — $5.25; 6" — $6.75; 8" — $9.75; 10" — $16.75; 12" — $31.75.

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Aluminized Pyrex, f/8, corrected to ⅛ wave sodium light

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Aluminized Elliptical Flat—¼ wave

4¼-inch .. $24.00 6-inch .. $40.00
8-inch $85.00 10-inch $140.00
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Our years of experience in hand correcting, combined with production methods for grinding and polishing, make it possible for us to present these new reduced prices!

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15/16 dia. .... Immediate Delivery
100 power $5.00 150 power $5.00
Adapter tube $1.00
All prices plus postage.

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Set the circles to the book and to sidereal time and the star will be in the telescope.

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Circles enable you to find instantly any of the thousands of unique stars and galaxies that are invisible to the naked eye, as well as Neptune, Uranus, and Pluto.

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Besides the features of No. 3, this model has manually operated slow motion in right ascension, which permits close following of the star under observation.

Model No. 5. TEACHERS' MODEL for Schools $245.00

This model is well adapted for teaching purposes where the student receives instruction while the telescope follows the star, for an electric motor carries the telescope in approximate sidereal time.

Model No. 6. THE UNIVERSITY MODEL $550.00

This instrument is driven by a synchronous motor through anti-backlash gearing in sidereal time so accurate as to be within a few seconds of absolute sidereal time per year. It is well suited for photography, and for guiding has slow motion in both axes operated from the eyepiece by flexible shafts.

For telescopes larger than 12 inches, fork-type mountings are suggested. Some specifications for these can be seen in our advertisements in former issues of "Sky and Telescope." Quotations can be made to fit your requirements.

All-aluminum skeleton tubes can be made to provide ventilation for reflecting telescopes and to eliminate boiling effects under high power from air currents inside the tube.

13" Co-ordinate Circles guaranteed accurate to within 3 seconds of arc, with 720 divisions.

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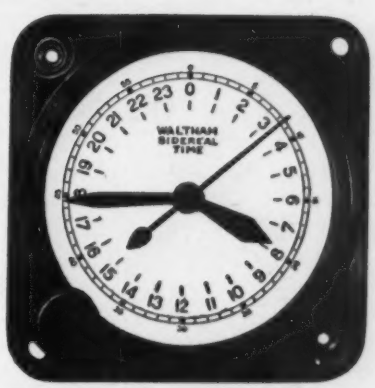

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2¾" O. D. 15" focal length

New — Achromatic — Coated

IN PEDESTAL MOUNT

Made to rigid government specifications by one of the world's leading producers of precision optical instruments.

Stock # 100A ..... $15.00 ea.

Same as above but unmounted —
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OBJECTIVE, COATED ACHROMAT, beautifully mounted for telescopic use. Clear aperture 1⅞ inches, focal length 27 inches. Long focal ratios like this are very scarce in war surplus stocks.

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EYE PIECE, HUYGHENIAN, E.F.L. one inch. Nickel plated brass mount. 15/16" O.D. x 1¾" long.

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ACHROMATIC ERECTING LENS SYSTEM, six elements, coated and mounted in 1¼ inch dia. by 1⅝ inch long aluminum mount. This is a really high grade erector made by the same company and for the same instrument as our # 100 A&B objectives.

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EYE PIECE E.F.L. one inch, removable reticle, coated lenses, field lens is an achromat, 1-1/16" dia. threaded mount. Clear aperture eye lens 15/16 inches. This eye piece was made for M-12 panoramic telescope.

Stock # 20 ..... $3.75 ea.

EYE PIECE E.F.L. ¾ inch, both eye and field lenses achromatic and coated. In focusing mount threaded for ¾" holder. Knurled focusing adjustment. Clear aperture eye lens 43/64 inch. Removable reticle.

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EYE PIECE—Large, from aircraft sighting station. In 2⅞ inch dia. threaded aluminum mount with locking ring. E.F.L. approx. 2 inches. Coated optics, clear aperture eye lens over 1¾ inches.

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Please use Stock No. when ordering.

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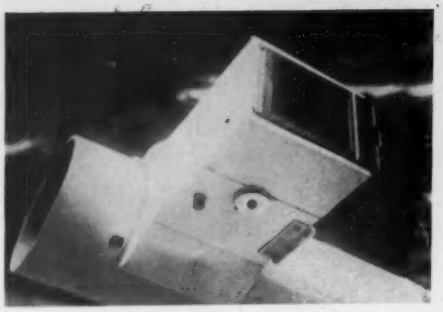

The cut-film holder and the metal disk used to trip the shutter.

light from the eyepiece. When the door is opened the eyepiece may be moved up and down for focusing, and, at the same time, the eyepiece swings clear to let the light form an image on the ground glass.

Outside the door is a metal disk mounted on a shaft; this bears a forklike piece to trip the Donald Duck shutter when the disk is turned. A short focal length for the eyepiece keeps the weight down, while a high eyepoint helps in positioning the shutter. Once this camera has been built for a specific eyepiece, that eyepiece is generally the only one usable with the camera. Ortho film is used in both cameras and the shutter speed is between 1/25 and 1/50 second.

It is advisable, when using cut film, to do your own darkroom work. This possible disadvantage is offset by the control you have over the development and the contrast and density of prints. This second type of camera is more difficult to build and use, but produces pictures much superior to those made with the Donald Duck arrangement first described.

GENE BARAFF
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Classified advertisements are accepted for this column at 40 cents a line per insertion, six words to the line. Minimum ad is three lines. Remittance must accompany orders. Address Ad Dept., Sky and Telescope, Harvard Observatory, Cambridge 38, Mass.

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FOR SALE: Gurley meteorological theodolite with tripod; never used, in original packing. Guaranteed perfect. Original cost $600.00. Will sell for $500.00. Science Associates, 401 N. Broad St., Philadelphia 8, Pa.

FOR SALE: 6" pyrex mirror, 50" f.l., reflecting telescope complete. Synthane tube. New. Make offer. Devaux, 215 E. 112 St., New York 29, N.Y.

FOR SALE: 10 power 80 mm. binocular made by E. Leitz. Collapsible tripod. Fine rich field glass. H. E. Bussey, Box 4659, Atlanta 2, Ga.

FOR SALE: 10" aluminized parabolic mirror f/9.3, pyrex, fully polished, 90% corrected. With aluminum and plywood cell and cap. $125.00. H. C. Buck, 11421 Sussex, Detroit 27, Mich.

FOR SALE: 12½" pyrex mirror, semipolished, 116" f.l. Also plate glass tool, cell, and eyepieces, 16 ga. sheet-metal tube 14" x 10', and 6" pipe fittings for mount. Write Jack R. Blake, Route 1, Portsmouth, Ohio.

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FOR SALE: German 20 x 80 mm. prismatic telescope, $50.00. Also prismatic binocular telescope, 15 x 80 mm. $150.00. Albert Mikolaitis, 50 Harlem, Worcester, Mass.

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25 mm Dia.	122 mm F.L.	coated	ea.	1.25
26 mm Dia.	104 mm F.L.	coated	ea.	1.25
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31 mm Dia.	124 mm F.L.	coated	ea.	1.50
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ACHROMATIC TELESCOPE OBJECTIVE 3" (76mm) dia., 15" (381 mm) F.L. Magnesium-fluoride coated and cemented. Mounted in aluminum cell. O.D. 3⅝". .... **Postpaid ea. $20.00**

ALUMINIZED MIRROR—First surface aluminized mirror. Polished to ¼ wave length of flatness. Packed in individual wooden boxes. Every mirror in sealed government inspected box. Mfgd. by Bausch & Lomb. Highest astronomical quality. Size 2½" x 3" x ½" thick. **Postpaid $3.00**

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WIDE ANGLE EYEPIECE—All coated optics, mounted in focusing cell, 2" clear aperture, 1½" F.L. 3 Achro. lenses. Value $125.00. Perfect. ea. **$9.50**

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MOUNTED KELLNER EYEPIECE E. F. L. 1½". O.D. of brass mount 1-17/32", clear aperture of field lens 1½", eye lens 13/16". **Postpaid $2.65**

4 POWER PANORAMIC TELESCOPE completely assembled, slightly used. Optically perfect. For the experimenter, contains Eyepiece, Amici Roof Prism, Achromatic objective lens, Dove Prism, silvered Right Angle Prism. **Postpaid $10.00**

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Government's 7 X 50 Binoculars

Here's an unusual opportunity to secure a fine set of Binoculars at a substantial saving of money. Offered here are complete sets of Optics and Metal Parts for the 7 x 50 Binoculars. These components are new and all ready for assembly. We supply full instructions. Limit — 1 set of Metal Parts and 1 set of Optics to a customer.

METAL PARTS—Set includes all Metal Parts — completely finished — for assembly of 7 x 50 Binoculars. No machining required. Bodies have been factory hinged and covered. A sturdy Binocular Carrying Case is optional with each set of Metal Parts.
Stock #842-Y ..... $39.40 Postpaid, plus $4.80 for Case ..... **Total $44.20**

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NOTICE! If you buy both the Binocular Optics and the Binocular Metal Parts, your purchase becomes subject to 20% Federal Excise Tax. Be sure to add amount covering tax to your remittance or your order cannot be filled.

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No Carrying Case with any Sets shown below. M-13A1 Sets are waterproof model. M-3 Sets are not waterproof. Limit — 1 Set to a Customer on all Sets shown below.

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SENSATIONAL BARGAIN

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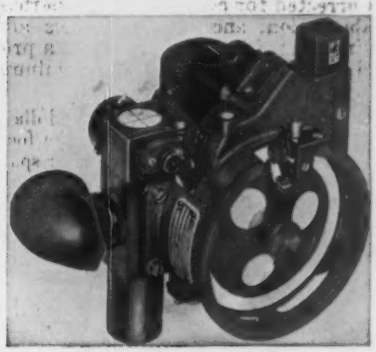

These Army Air Forces Bubble Sextants cost the Govt. about $125 each. A real bargain at our price of $12.50! Included with Bubble Sextant shipment is wooden Carrying Case, 5 spare waxed paper discs, flashlight with rheostat for night use (uses ordinary flashlight cells—not furnished) aux. 2-power Galilean Telescope, Allen wrench, 1 spare marking point. Wartime used, but where necessary completely repaired, collimated and put in good working order. Light bulb has been tested—Bubble is in working condition. Because of wartime use, we make this guarantee: if not satisfied that Sextant is exactly as represented, return within 10 days and money will be refunded. Full directions for use accompany each shipment.
Stock #924-Y ..... $12.50 Postpaid
Same SEXTANT as above, but new and with Automatic Electric Averaging Device and illuminated Averaging Disc for nighttime use. Govt. cost $217.
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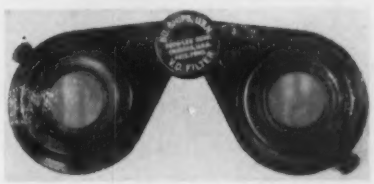

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Stock #20,000-Y ..... $2.00 Postpaid
Above Polarizing Attachment also adaptable to Govt. 6X30 Binoculars with substitution of special Eye-cups.
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SCHMIDT OPTICAL SYSTEM. Black plastic body, size 3-15/16" by 5-½". F.L. 2.4" . . . with amazing speed of F.0.9. Used in Navy's Infra-Red Sniperscope and Signalling Units. Govt. cost $134. Limit — 1 to a customer.
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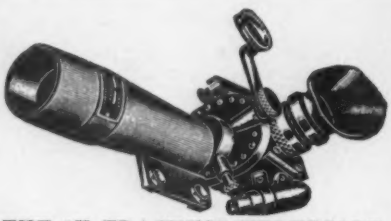

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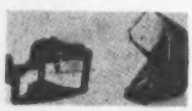

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OBSERVER'S PAGE

Greenwich civil time is used unless otherwise noted.

Timing the Contacts of a Partial Solar Eclipse

THERE ARE very few things that an amateur astronomer can do with a partial eclipse of the sun. He can watch the occultation of sunspots; he can look for mountains on the moon's rim; or he can try to determine roughly the times of contact. The latter is often very difficult because of atmospheric boiling around the rim of the sun. Below is offered a method for determining the times of contact which reduces the boiling to an unimportant factor.

The partial solar eclipse of November, 1946, provided an opportunity for observers at the Van Vleck Observatory of Wesleyan University to test this method. It was originally devised by Minnaert in Holland, and translated into English by Mulders, the translation appearing in the **Publications** of the Astronomical Society of the Pacific, Vol. 50, page 267.

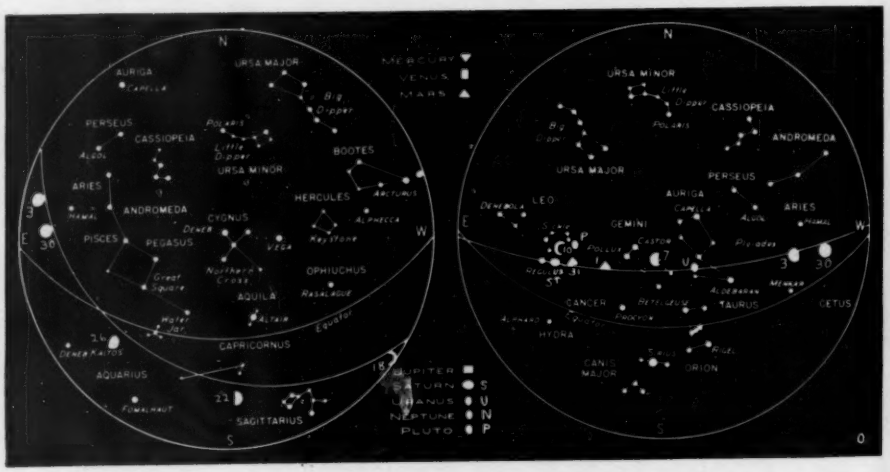
Mulders' formula was used in our observations:

$$\mathbf{T} = \mathbf{t} + \mathbf{T}_0 (1 - \sqrt{1 - \mathbf{f}^2}),$$

in which **T** is the calculated time of contact, counted from the maximum; **t** is the time of observation, counted from the maximum; **f** is the ratio of the observed chord (from cusp to cusp) to the maximum chord length; and $\mathbf{T}_0$ is an approximate value set for the time of contact.

While Dr. C. Stearns took photographs of the eclipse through the 20-inch refractor, the undersigned students made measurements with the 4-inch finder (focal length 27.9 feet), observing the 3-inch

THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 5:30 a.m. local time on the 7th of the month, and at 4:30 a.m. on the 23rd. At the left is the sky for 7:30 p.m. on the 7th and 6:30 p.m. on the 23rd. The moon is shown for certain dates by symbols which give roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Mercury remains in the evening sky all month, coming to elongation on October 13th, when the planet is 25° east of the sun. However, this is not a favorable apparition in the Northern Hemisphere, as Mercury sets about three quarters of an hour after sunset. The 2-day-old moon passes 4° north of Mercury on the 15th.

Venus increases its apparent distance from the sun to 15° by the end of October. At the end of the month, it may be seen very low in the southwest sky in the evening twilight.

Mars rises about local midnight. During October the planet crosses the constellation of Cancer and comes to within 5° of Saturn. On the night of the 12-13th, it passes through the southern edge of the Beehive, M44. Field glasses are needed best to view this conjunction. The magnitude of the planet changes from +1.3 to +1.0 through the month of October.

Jupiter follows shortly after the sun, setting about 1½ hours later. The giant planet continues its eastward motion and by the end of the month is located 1° from Beta Scorpii.

Saturn may be found in western Leo as a morning object. The ringed planet has moved to within 10° of Regulus, and to the west Mars is rapidly approaching. Saturn is brighter than either, at magnitude +0.7.

Uranus starts retrograde motion on the 2nd, as opposition approaches in December. It is in eastern Taurus, about 2° northeast of Zeta. The position on the 15th is $5^h\ 43^m.0$, +23° 31'.3, and the planet is 6th magnitude.

Neptune is in conjunction with the sun on October 4th, and hence is not visible.

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focal-plane image of the sun without an eyepiece.

From Mulders' formula, we note that the unknown **T** can be obtained if **f** and **t** are known. One observer, using a pair of dividers, measured the length of the chord from cusp to cusp, and another recorded the time of this measurement. By taking a number of such observations, the error resulting from the crude methods may be reduced enormously. Several observations during the middle of the eclipse clearly revealed the turning point, and the largest length of chord was obtained. By averaging all the **T**'s obtained from substitution in the formula, the times of contact were found.

A chronometer is best for recording the time of the observations, but it is by no means essential if a good watch and accurate time are available. The timepiece should be rated accurately beforehand, and its error in time and rate compensated for in the final contact times.

The following are two sets of results, together with the times predicted in the **American Ephemeris**:

	First Contact	Last Contact
Widing	15:52:36	19:01:22.4
Lindenblad	15:52:41.5	19:01:16.4
Ephemeris	15:52:37.1	19:01:07.9

Partial eclipses of the sun, such as the one this November 12th, should furnish opportunity for other amateurs to try this method.

KENNETH WIDING
IRVING LINDENBLAD
Wesleyan University
Middletown, Conn.

MINIMA OF ALGOL

October 1, 22:01; 4, 18:49; 7, 15:38; 10, 12:27; 13, 9:15; 16, 6:04; 19, 2:53; 21, 23:42; 24, 20:30; 27, 17:19; 30, 14:08. November 2, 10:57; 5, 7:46.

PHASES OF THE MOON

Last quarter	October	7, 10:29
New moon	October	14, 6:10
First quarter	October	22, 1:11
Full moon	October	29, 20:07
Last quarter	November	5, 17:03

COMET NOTES

There are several comets in the sky at the present time, all of them too faint for observation with any but large instruments. Those wishing to keep abreast of comets should subscribe to Harvard Announcement Cards, which may be ordered from Harvard Observatory, Cambridge 38, Mass., for one dollar for mailings of 25 cards.

Comet Encke, which is now on its 43rd return since its discovery in 1786, went unobserved in 1944. But on August 14th of this year, Dr. H. M. Jeffers, of Lick

GREENWICH CIVIL TIME (GCT)

TIMES used on the Observer's Page are Greenwich civil or universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the GCT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

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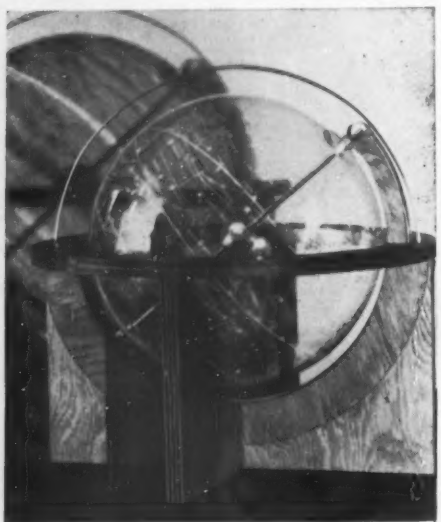

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Observatory, found the comet near its predicted position. It was of the 18th magnitude, but should have brightened rapidly during September. In the event it attains the possible predicted magnitudes, the following predictions from the **Handbook** of the British Astronomical Association will be useful to amateurs possessing telescopes.

		h	m	°	′	*Mag.*
Oct.	2	5	46.1	+46	22	
	6	6	24.8	48	23	10.3
	10	7	14.6	49	41	
	14	8	16.2	49	29	9.4
	18	9	24.4	46	45	
	22	10	29.6	41	06	8.6
	26	11	24.3	33	19	
	30	12	07.2	24	48	8.1
Nov.	3	12	40.3	16	39	
	7	13	06.3	+9	24	7.6

Added in press: HAC 841 gives a new ephemeris by Dr. L. E. Cunningham.

The year 1947 may well establish a record for new comets. In 1932, 13 comets were found, and with the discovery in July of Comet Wirtanen (1947h) by a Lick Observatory astronomer, the rate this year seems greater than ever. But not one of these eight comets has been visible or will be visible to the unaided eye.

PERSEID SHOWER REPORTS

Perfect weather enabled Richard Kingman, of Holland, Mich., to observe 97 meteors in an hour after midnight on August 12th, the time of the maximum of the Perseid shower. He also counted 67 in an hour on August 9th, and 51 in 1½ hours on the 5th. Many colored meteors were seen, several matching Jupiter in brightness.

At Pasco, Wash., Walter Oberst found hourly rates of nearly 30 meteors on the evening of August 12th, which increased to 60 per hour the next morning. Sky conditions were perfect.

Until the night of the maximum, clear skies prevailed at Omaha, Neb., where Robert J. Davis and H. C. Davis attempted photography from two positions, one in Iowa and one in Nebraska. These observers noted that the shower was easier to observe than the one of last October 9th, for the meteors were few enough to permit concentration on each one, without confusion.

At Danbury, N. H., clear skies also prevailed, where two nights before the maximum the managing editor of **Sky and Telescope** and Tony Federer observed the Perseids, keeping hourly counts and separately recording sporadic and shower meteors.

METEORS IN OCTOBER

One of the more prominent annual meteor showers may be observed this month. On the nights of October 19th through 22nd, swift meteors will be seen radiating from a point 5° northeast of Betelgeuse, in Orion, and therefore known as the Orionids. For all meteors seen, rates of 20 meteors per hour may be expected at maximum, and smaller numbers for several days before and after. The moon is at first quarter on October 22nd, in Capricornus, in the opposite region of the sky.

You will recall the Giacobinid shower in 1946 as the most brilliant meteor display thus far this century. Some stragglers may be seen this year, and possibly large numbers, though not expected. The radiant is near the head of Draco, and the moon will not interfere — it is at last quarter. A night spent meteor observing on October 9th is suggested, and perhaps on the 8th and 10th.

OCCULTATION PREDICTIONS

October 4-5 **Tau Tauri** 4.3, 4:39.1 +22-51.4, 20, Im: **A** 2:09.6 +0.2 +1.2 87; **B** 2:13.5 +0.2 +1.3 82. Em: **A** 3:00.5 +0.2 +1.8 233; **B** 3:05.9 +0.1 +1.7 239; **D** 3:03.9 +0.2 +1.6 242.

5-6 **139 Tauri** 4.9, 5:54.7 +25-57.0, 21, Em: **A** 10:14.1 −1.8 +2.0 227; **C** 9:56.2 −1.7 +3.6 211; **D** 10:04.1 −1.7 +1.7 234; **E** 9:38.7 −1.4 +2.4 229; **F** 8:59.2 ... ... 197; **G** 9:24.9 −1.2 +0.8 287; **H** 9:01.8 −0.7 +1.5 256; **I** 9:14.1 −1.0 +0.7 295.

6-7 **39 Geminorum** 6.1, 6:55.5 +26-09.2, 22, Em: **A** 8:27.7 ... ... 206; **B** 8:38.2 −0.9 +3.0 223; **C** 8:04.7 ... ... 186; **D** 8:28.0 −0.7 +3.1 222; **E** 8:11.9 −0.2 −2.7 224; **F** 7:39.0 ... ... 189; **G** 8:22.5 −0.4 +1.2 281; **H** 8:02.5 +0.1 +1.4 254; **I** 8:18.3 −0.2 +1.0 288.

6-7 **40 Geminorum** 6.3, 6:56.2 +25-59.3, 22, Em: **G** 8:36.1 −0.1 +2.0 242; **H** 8:03.8 +1.0 +2.9 207; **I** 8:33.4 +0.1 +1.8 249.

9-10 **Eta Leonis** 3.6, 10:04.4 +17-01.3, 25, Im: **A** 10:38.8 −1.2 +0.1 117; **C** 10:34.0 −1.2 −0.5 131; **D** 10:31.4 −1.0 +0.4 114; **E** 10:20.6 −0.7 +0.1 124; **F** 10:23.6 −1.1 −2.6 163; **G** 10:25.8 +0.1 +2.0 74. Em: **A** 11:52.2 −1.6 0.0 290; **C** 11:43.5 −1.7 +0.7 274; **E** 11:25.0 −1.1 +1.0 275; **F** 10:58.9 −0.5 +3.6 231; **G** 11:13.7 −0.5 0.0 319; **I** 11:09.9 −0.3 0.0 321.

19-20 **Tau Sagittarii** 3.4, 19:03.6 −27-45.0, 6, Im: **A** 21:04.5 −1.9 −0.7 138; **C** 20:59.9 −1.5 −1.4 149. Em: **A** 22:03.1 −1.9 +1.2 217; **B** 22:04.0 −1.9 +0.9 222; **C** 21:47.1 −2.4 +2.3 209.

30-31 **13 Tauri** 5.5, 3:39.3 +19-31.9, 17, Em: **A** 11:32.9 −0.2 −0.9 254; **C** 11:33.3 −0.5 −0.3 239; **E** 11:23.1 −0.9 +0.1 233; **G** 10:52.7 −1.3 −1.0 269; **H** 10:40.0 −1.6 +1.7 219; **I** 10:40.9 −1.6 −0.6 268.

October 31-November 1 **67 Tauri** 5.4, 4:22.3 +22-04.8, 18, Em: **A** 2:49.9 −0.2 +2.2 220; **B** 2:56.0 −0.3 +2.1 228; **C** 2:41.3 −0.1 +2.2 220; **D** 2:50.6 −0.2 +1.9 232;

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November: LIGHTHOUSES OF THE SKY.

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November: STAR RAINBOWS.

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November: ECLIPSES.

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October: FALL SKIES. Columbus navigated by the same stars used today. This month we shall show you some easy ways to identify the more important navigation stars and autumnal constellations.

November: THE STAR THAT MAKES THE WEATHER.

E 2:42.5 0.0 +1.7 241; **F** 2:27.1 +0.3 +1.6 230.

October 31-November 1 **Kappa Tauri** 4.4, 4:22.2 +22-10.5, 18, Im: **A** 1:55.3 −0.3 +1.6 72; **B** 1:59.9 −0.2 +1.7 66; **C** 1:48.7 −0.2 +1.5 73; **D** 1:56.0 0.0 +1.7 62; **E** 1:51.4 +0.3 +1.6 56; **F** 1:39.4 +0.4 +1.2 66. Em: **A** 2:56.3 −0.5 +1.8 240; **B** 3:00.8 −0.6 +1.7 243; **C** 2:47.7 −0.4 +1.8 240; **D** 2:54.7 −0.5 +1.6 252; **E** 2:44.7 −0.3 +1.4 260; **F** 2:30.9 +0.1 +1.3 250; **G** 2:52.1 −0.2 +0.9 305.

October 31-November 1 **284 B Tauri** 6.0, 4:33.3 +23-14.1, 18, Em: **A** 9:15.7 −1.4 −0.6 260; **B** 9:11.7 −1.4 −1.0 270; **C** 9:09.4 −1.7 +0.1 247; **D** 9:04.5 −1.6 −0.6 264; **E** 8:44.3 −1.9 +0.3 255; **F** 8:18.6 −1.8 +2.0 227; **H** 7:44.0 −2.0 +0.4 280.

November 1-2 **118 Tauri f** 5.9, 5:26.0 +25-06.6, 19, Em: **A** 3:56.9 −0.3 −2.3 225; **B** 4:03.0 −0.4 +2.1 234; **C** 3:48.0 −0.1 +2.2 223; **D** 3:57.1 −0.3 +1.9 238; **E** 3:48.2 −0.1 +1.6 246; **F** 3:32.8 +0.3 +1.6 234; **G** 3:59.7 −0.1 +1.1 292; **I** 3:58.1 0.0 +0.8 300.

For selected occultations (visible at three or more stations in the U. S. and Canada under fairly favorable conditions), these predictions give: evening-morning date, star name, magnitude, right ascension in hours and minutes and declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, GCT, a and b quantities in minutes, position angle; the same data for each standard station westward.

Longitudes and latitudes of standard stations are:

A	+72°.5, +42°.5	**E**	+91°.0, +40°.0
B	+73°.6, +45°.6	**F**	+98°.0, +30°.0
C	+77°.1, +38°.9	**G**	+114°.0, +50°.9
D	+79°.4, +43°.7	**H**	+120°.0, +36°.0
		I	+123°.1, +49°.5

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude respectively, enabling computation of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Greenwich civil time to your own standard time.

For additional occultations consult the American Ephemeris and Nautical Almanac and the British Nautical Almanac, from which these predictions are taken. Texas predictions were computed by E. W. Woolard and Paul Herget.

VARIABLE STAR MAXIMA

October 1, U Cygni, 7.6, 201647; 3, X Ophiuchi, 6.9, 183308; 7, W Andromedae, 7.5, 021143a; 7, R Ophiuchi, 7.6, 170215; 13, R Leo Minoris, 7.2, 093934; 21, T Centauri, 6.1, 133633; 21, R Draconis, 7.6, 163266; 22, Omicron Ceti (Mira), 3.7, 021403. November 5, R Phoenicis, 7.8, 235150.

These predictions of variable star maxima are made by Leon Campbell, recorder of the AAVSO, Harvard College Observatory, Cambridge 38, Mass. Serious-minded observers interested in making regular telescopic observations of variable stars may write to Mr. Campbell for further information.

Only stars are included here whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

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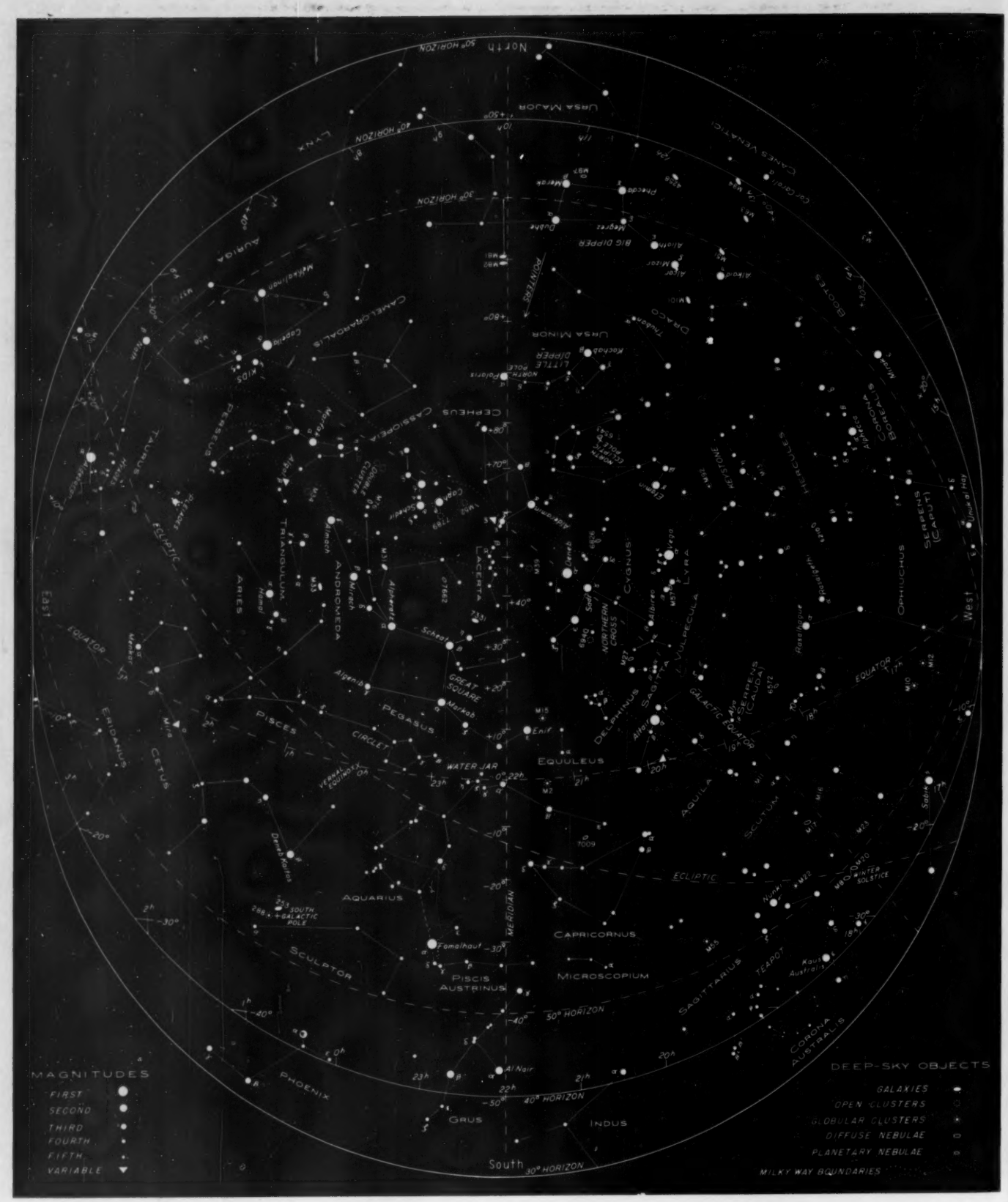

DEEP-SKY WONDERS

THE SOUTH galactic pole area, 0^h to 2^h, $-20°$ to $-40°$, is within the reach of American amateurs, especially those in the southern states. One may find a globular cluster, no galactic, and, curiously, only 16 spirals brighter than 13.0, in contrast to the northern galactic pole region which abounds in spirals.

NGC 2708, 281[1], about 1^h 32^m, $-29°$ 45′, a Herschel spiral not listed in Harvard **Annals** 88, 2, but glimpsed with a 10-inch reflector in Louisiana. **NGC 288,** 20[6], 0^h 48^m, $-27°$ 08′, a bright globular cluster, 10′ diam., mag. 7.2, not listed in Webb or Smyth and unknown to most amateurs.

NGC 253, 1[5], 0^h 45^m, $-25°$ 34′, 22′ x 6′, mag. 7, a bright spiral, pictured on the front cover of **Sky and Telescope** of May, 1946, well worth the search. **NGC 55,** 0^h 13^m, $-39°$ 30′, spiral, 25′ x 3′, mag. 7.8. **NGC 625,** 1^h 33^m, $-41°$ 41′, spiral, 2.5′ x 1′, mag. 12.3; will be troublesome to find except in excellent skies and larger amateur telescopes.

WALTER SCOTT HOUSTON

STARS FOR OCTOBER

from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.

Chart correction: Beta and Gamma Lyrae should be reversed.

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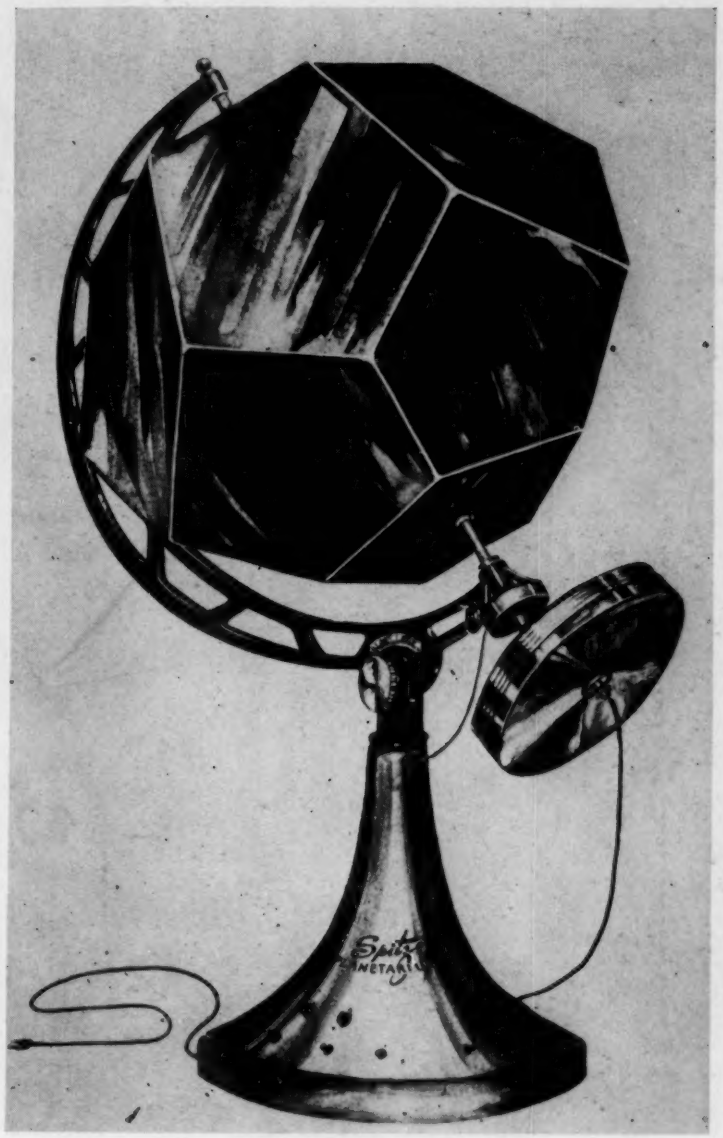

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